30.5306:7
S
338.47676
H2hwp
1974

FINAL:

ENVIRONMENTAL IMPACT STATEMENT FOR THE PROPOSED EXPANSION OF THE

HOERNER-WALDORF PULP AND PAPER MILL AT MISSOULA, MONTANA

November 6, 1974

Department of Health and Environmental Sciences,
John S. Anderson, M.D., Director
Environmental Sciences Division,
Benjamin F. Wake, Administrator
Air Quality Bureau,
Don Holtz, Chief

MONTANA STATE LIBRARY
3 0864 0015 2454 8

Department of Health and Environmental Sciences
STATE OF MONTANA HELENA, MONTANA 59601

John S. Anderson M.D.
DIRECTOR

STATE OF MONTANA/RECEIVED
NOV 8 1974
INTERGOVERNMENTAL RELATIONS
RESEARCH & INFORMATION SYSTEMS DIV.

November 6, 1974

Ladies and Gentlemen,

This final environmental impact statement has been prepared in compliance with the Montana Environmental Policy Act. Comments or questions regarding the statement or the Hoerner-Waldorf project may be addressed to the undersigned.

Because of requirements that the requested permit must be denied or granted within a fixed time after application, the usual 30-day period between issuance of the final statement and final action on the permit is not available. The permit will be granted or denied and the public informed prior to December 1, 1974.

Sincerely,

Daniel Vichorek

Daniel Vichorek
Technical Writer
Environmental Sciences Division

DV/sss

Mailing List of Persons Receiving Hoerner-Waldorf Final Environmental Impact Statement

Governor Thomas Judge, State Capitol Building, Helena, Montana 59601
Montana State Library, 930 East Lyndale, Helena, Montana 59601
Missoula Public Library, Missoula, Montana 59801
University of Montana Library, University of Montana, Missoula, Montana 59801
Ron Erickson, Chemistry Department, Universityoof Montana, Missoula, Montana 59801
Hoerner-Waldorf Corporation, Missoula, Montana 59801
Don Schwenessen, The Missoulian, Missoula, Montana 59801
Missoula Area Chamber of Commerce, 207 East Main Street, Missoula, Montana 59801
Maxine Johnson, Economics Department, University of Montana, Missoula, MT 59801
Malinda Schall, Economics Department, University of Montana, Missoula, MT 59801
Thomas M. Power, Route 2, Bass Creek, Stevensville, MT 59870
Dr. Clancy Gordon, Botany Department, University of Montana, Missoula, MT 59801
Arnold Silverman, Geology Department, University of Montana, Missoula, MT 59801
Mayor Robert E. Brown, City of Missoula, Missoula, Montana 59801
Peggy Schaefer, GASP, 500 Daly Avenue, Missoula, MT 59801
Samuel Reynolds, The Missoulian, Missoula, MT 59801
Richard Konizeski, School of Forestry, University of Montana, Missoula, MT 59801
Robert Curry, Department of Geology, University of Montana, Missoula, MT 59801
Don Aldrich, Montana Wildlife Federation, 410 Woodworth Avenue, Missoula, MT 59801
Doris Milner, Montana Wilderness Association, Route 1, Box 1410, Hamilton, MT 59840
Bill Kendall, Trout Unlimited, 715 Beverly Street, Missoula, MT 59801
Board of County Commissioners, Missoula County, Missoula, Montana 59801
City-County Health Department, Courthouse Annex, Missoula, MT 59801
City-County Planning Office, Missoula, MT 59801
Bill Tomlinson, Student Environmental Research Center, Venture Center, University of Montana, Missoula, MT 59801
Dean, School of Forestry, University of Montana, Missoula, MT 59801
James Posewitz, Administrator, Environment and Information Division, Department of Fish and Game, Mitchell Building, Helena, Montana 59601
Department of Conservation and Natural Resources, 32 S. Ewing, Helena, MT 59601
Department of State Lands, Capitol Building, Helena, MT 59601
Division of Planning and Economic Development, Capitol Building, Helena, MT
Region 1, U. S. Forest Service, Missoula, MT 59801
Bureau of Land Management, State Headquarters, Federal Building, Billings, MT
Fern Hart, League of Women Voters, 16 Carriage Way, Missoula, MT 59801
Inland Forest Resources Council, Howard McDowell, 612 Savings Center Building, Missoula, Montana 59801
Montana Wood Products Association, W. M. Kirkpatrick, 612 Savings Center Building Missoula, Montana 59801
Lester Tschannen, Big Sky West 2717 Valley View, Missoula, Montana 59801
Evans Products, W. R. Bickerton, Drawer L, Missoula, MT 59801
U. S. Plywood, W. E. Butler, Drawer 7, Bonner, Montana
E. L. Owen, 7001 Bitterroot Road, Missoula, MT 59801
Bureau of Land Management, 1819 Holborn, Missoula, MT 59801
Clint Carlson, U. S. Forest Service, Federal Building, Missoula, MT 59801
Charles O'Boyle, Region VIII, Environmental Protection Agency, 1860 Lincoln Street, Denver, Colorado 80203
James Herlihy, OAP, R.T.P, Environmental Protection Agency, Research Triangle Park, NC 27711

Lee State Bureau, 317 Allen Street, Helena, MT 59601
Tom Kotynski, Tribune Capitol Bureau, Helena, MT 59601
Associated Press, 317 Allen, Helena, Montana 59601
United Press International, Helena, Montana 59601
J. W. Bartlett, Chairman, P. O. Box 788, Whitefish, MT 59937
Mrs. Rita Sheehy, 1041 Poly Drive, Billings, MT 59101
R. C. Ritter, D.D.S., P.O. Box 1170, Bozeman, MT 59715
John Newman, M.D., P.O. Box 3493, Butte, MT 59701
Dr. John M. McGregor, Great Falls National Bank Building, Great Falls, MT 59401
Leonard Eckel, 1727 11th Avenue, Helena, Montana 59601
Dr. William Spoja, Courthouse, Lewistown, Montana 59457
John S. Anderson, M.D., Director, State Department of Health and Environmental Sciences, Cogswell Building, Helena, Montana 59601
Douglas Ashton, 4041 Helberg Drive, Helena, Montana 59601
Richard Dightman, 1822 Winne Avenue, Helena, Montana 59601
Walter Everly, P.O. Box 603, Butte, Montana 59701
Bruce A. Allison, M.D., 502 Second Avenue East, Kalispell, Montana 59901
Lewis J. D. Maxson, 1726 Sherwood, Missoula, MT 59801
Frank Popiel, 1212 S. Second, Hamilton, Montana 59840
Conrad O. Orr, DVM, 3701 Highway 93 South, Missoula, MT 59801
Paul Kleffner, East Helena, Montana 59635

Dr. Francis E. Murray, Head
Dept. of Chemical Engineering
University of British Columbia
2075 Wesbrook Place
Vancouver, B.C., Canada
V6T 1W5

Konrad Semrau
Stanford Research Institute
333 Ravenswood Ave.
Menlo Park, CA 94205

Dr. Michael J. Pilat
Associate Professor of Air Resources Engineering
Water & Air Resources Division
Dept. of Civil Engineering FX-10
University of Washington
Seattle, Washington 98295

TABLE OF CONTENTS

	Page
Summary	
I. Introduction	1
A. Description of the Proposed Action	1
II. Description of Plant and Process	13
A. Basic Manufacturing Process	13
B. Sources and Nature of Pollution	19
C. History of Pollution and Control at Hoerner-Waldorf	28
D. Energy and Raw Material Consumption	38
E. Wastewater Treatment and Control	39
III. Existing Environment and Possible Effects of Expansion	47
A. Air Quality	47
B. Water Quality	101
C. Social and Economic Considerations	140
D. Wood Waste Supply	147
E. Vegetation	153
IV. Actions Available to SDHES	167
A. Statutory Authority	167
B. Alternatives Available to HW	168
V. Environmental Impacts of Actions Available to the Department	179
A. If the Permit Were Denied	179
B. If the Permit Were Granted as Requested	180
VI. Response to Public Opinion	182
VII. Conclusion	184
References	188
Appendix A - Air Quality Regulations	A-1
Appendix B - Water Quality Laws, Regulations, and Compliance Schedules	B-1
Appendix C - Quality Control of Gas Chromatograph Monitoring	C-1
Appendix D - Diffusion Model for Hoerner-Waldorf H_2S	D-1
Appendix E - Comments of Dr. Kit Johnson	E-1
List of Authors and Qualifications	

SUMMARY

The Hoerner-Waldorf Corporation (HW) has applied to the Air Quality Bureau (AQB) of the State Department of Health and Environmental Sciences (SDHES) for a permit to expand its existing pulp and paper mill in Missoula, Montana.

Under the expansion plan, various pollution control devices would be installed, in addition to those already under construction to lessen emissions and discharges from the existing mill. If the expansion were allowed, emission of most air pollutants would continue at a rate lower than at present, but higher than if the plant were not expanded but was operated with the pollution control measures now under construction or in the planning stages. Particulate sulfate emissions would increase under the plan submitted by HW.

Visibility could decrease after the expansion. The odor problem would continue to some extent, but with fewer and less severe episodes than at present.

The information available to date indicates the expanded plant could be operated to comply with all air and water quality standards. Some economic benefits would accrue from the expansion, but their extent and significance is in contention.

Following further review of the available information and in view of the public response to the draft statement, SDHES intends to issue the permit, contingent upon an agreement in advance by HW to meet certain pollution control specifications, as listed in Section VII.

I. INTRODUCTION

A. Description of the Proposed Action

HW has applied to the AQB for a permit to expand the capacity of its pulp and paper mill from 1150 tons per day (TPD) of paper products to 1850 TPD. Operation of the expanded plant would affect air pollution from the mill, and therefore a permit is required under regulations appurtenant to the 1967 Clean Air Act of Montana. The act and subsequent regulations say there shall be no "installation, alteration, or use of any machine, equipment, device or other article which . . . may cause or contribute to air pollution . . ." unless a permit is issued.

According to HW, the proposed expansion would cause increased emission of particulates including sulfates, with no increase in SO_2, and reduction in total reduced sulfur (TRS) emissions.

A more detailed explanation of the air pollutants generated in the production of paper requires technical explanation of the process, which is given in Section II of this statement. Air pollution sources and new types and methods of controls also will be discussed in the later section.

Other air pollution laws affecting the proposed expansion are listed in Appendix A.

HW says the 745 acres of ponds receiving the liquid discharge from the plant are the primary source of air pollution caused by the paper making operation.

It appears that odorous hydrogen sulfide and perhaps small amounts of some other gases are released from the ponds as a result of the action of anaerobic bacteria. Generally, HW will attempt to reduce odorous emissions from the ponds through the installation of an aeration system. If oxygen were introduced into the ponds by an aeration system, aerobic bacteria would replace the anaerobic bacteria which generate hydrogen sulfide in breaking down the sulfate material produced by the mill. At present, 15.8 million gallons per day (MGD) of liquid effluent are discharged to the ponds. About one-third of the liquid entering the ponds is discharged to the river during spring runoff. The remainder either evaporates or infiltrates through the bottom of the ponds. If the proposed expansion were carried out, discharge to the ponds would increase to a level of about 21.6 MGD. Up to 325 acres of new ponds might be required.

The discharge of liquid effluents is controlled by the State Water Quality Bureau (WQB) through a wastewater discharge permit. The discharge permit is contingent upon HW's efforts to meet a compliance schedule designed to reduce the extent of water pollution from the mill. The wastewater discharge permit soon to be issued for the existing discharge is shown in Appendix B. Following the permit is a discussion of the compliance schedule contained in the permit and a review of the standards pertaining to the expansion. The permit to be issued by the state was prepared following a public hearing at Missoula on May 29, 1974 and the review of information submitted by both EPA and the Water Quality Bureau.

Section 301(b) of federal Public Law 92-500 (the Act), requires the achievement by not later than July 1, 1977 of liquid effluent limitations for point sources, other than publicly owned treatment works, which require the application of the best practical control technology (BPCT) currently defined by the administrator of the EPA pursuant to Section 304(b) of the Act. Section 301(b) also requires the achievement by not later than July 1, 1983 of liquid effluent limitations for point sources, other than publicly owned treatment works, which require the application of best available technology (BAT) economically achievable. Section 306 of the Act requires the achievement by new sources of federal standards of performance for the control of the discharge of pollutants which reflects the greatest degree of effluent reduction which the administrator determines to be achievable through application of the best available demonstrated control technology, processes, operating methods or other alternatives. The proposed expansion would be subject to the best practicable treatment standards.

The EPA development document (1) details the ananyses undertaken in support of the proposed regulations. An EPA economic analysis of the industry also has been published (2). The guidelines and standards for the unbleached pulp, paper and paperboard manufacturing point source category were published in the Federal Register on May 29, 1974 (Volume 39, No. 104, Part I) and summarized below:

	Best Practicable Treatment	Best Available Technology	New Source Performance Standards
Biochemical Oxygen Demand BOD_5 (lbs/ton of production)			
Maximum for any one day	11.2	5.4	6.2
Maximum average daily values for 30-day periods	5.6	2.7	3.1
Total Suspended Solids TSS (lbs/ton of production)			
Maximum for any one day	24.0	7.4	15.0
Maximum average daily values for 30-day periods	12.0	3.7	7.5
Color (lbs/ton of production)			
Maximum for any one day	No specific requirement	30	30

	Best Practicable Treatment	Best Available Technology	New Source Performance Standards
Maximum average daily values for 30-day period	No specific requirement	20	20
pH	6.0 to 9.0	6.0 to 9.0	6.0 to 9.0

Regulations for the bleached pulp industry are yet to be issued. These may require additional treatment of the bleach plant wastewater above that presently proposed by HW.

The EPA also has issued regulations for the National Pollutant Discharge Elimination System (NPDES) program, as printed in the Federal Register on May 22, 1973 (Volume 38, No. 98, Part III).

The EPA issued a public notice of its proposal to issue a waste discharge permit to HW, and a public hearing was held at Missoula on May 29, 1974. The proposed permit would expire on December 31, 1977.

The federal NPDES program mentioned above came under state authority on June 10, 1974. A regulation (MAC 16-2.14(10)-S14460) entitled "Montana Pollutant Discharge Elimination System" (MPDES) was adopted by the State Board of Health and Environmental Sciences on January 18, 1974, and became effective on March 8, 1974. This regulation was adopted to provide Montana with a program comparable to that of EPA. This HW permit for the existing discharge must now be issued or denied by the state, since EPA turned over the MPDES program to the State Department of Health and Environmental Sciences.

To meet the compliance schedule established by SDHES, HW installed aeration equipment in a two-stage aeration basin. Startup of the facilities is awaiting delivery of a few items necessary to its operation. The new treatment system includes ten 150-horsepower mechanical aerators in the first stage of the basin with two similar aerators in the second stage, all of which follow the existing clarifier. The aeration basin has an area of approximately 35 acres and an average depth of 12 feet. At the present level of production, each stage of the aeration basin would have a detention time of about four days. Based on the design submitted by HW, the 1800 horsepower aerator installation would reduce the BOD_5 concentration from an average of 480 milligrams per liter entering the basin to a level of 24 milligrams per liter (under winter conditions) for the present mill. This represents an efficiency of 95 percent. It is expected that further BOD_5 reduction will be realized in the first ponds (1 and 15) following the aeration basins. The consultants for HW indicate that the BOD_5 concentration in the treated wastewaters directly discharge to the river will be about 7 milligrams per liter.

HW predicts that 2,160 pounds per day of nitrogen and 450 pounds per day of phosphorus will be required to facilitate BOD reduction by bacteria for the existing production level. For the expanded mill, 2,430 pounds of nitrogen and 510 pounds of phosphorous would be required daily. Some of the added nutrients would be removed from the treated wastewater by seepage, but the removal efficiency can only be roughly estimated.

Some of the nutrient needed by the bacteria is contained in wastewaters generated in the paper making process, but not enough, so some would be added in liquid form to the clarifier effluent.

The estimated maximum amount of P and N that would be added is as follows:

Nutrients	Present Production (after biological treatment)	Expanded Production (after biological treatment)
P	425 #/d	485 #/d
N	1600 #/d	1870 #/d

Phosphorus is usually added in the form of phosphoric acid. Nitrogen is usually added in the form of ammonia. It should be noted that because of the expense of these nutrient materials, it can be expected that HW will only add sufficient nutrients to allow for enough microbiological growth to achieve acceptable BOD reductions. In other words, the biological system will be operated in such a manner as to have nutrients in the system the limiting factor in the organic materials degradation process.

The use of sewage and/or sewage sludge as a source of nutrients probably would be infeasible because of hauling and handling costs. Plus, both would increase the BOD and TSS load on the waste treatement system. In addition, the use of sewage and/or sewage sludge would not allow a good control of the nutrient feed since the nutrient content of the aforementioned materials is highly variable. The reasons that feedlot wastes are not practical are the same as those for sewage and/or sewage sludge.

At the expanded production level, each stage of the aeration basin would have a detention time of more than 2.5 days. According to the design submitted by HW, the aeration basin would reduce the BOD_5 concentration from an average of approximately 310 milligrams per liter entering the basin to approximately 30 milligrams per liter (under winter conditions) for the expanded mill. The consultants for HW indicate that the BOD_5 concentration in the treated wastewaters directly discharged to the river will be approximately 13 milligrams per liter for the expanded mill.

In addition to reducing BOD_5 of the effluent, the aerated treatment should substantially reduce the odor problem associated with the ponds used for aeration, settling, and storage, and should reduce the effluent toxicity, taste, odor, and foaming tendencies. The concentration of phenol in the effluent probably will be reduced to 0.1 milligram per liter. Little color reduction can be expected by this treatment. Some odors may emanate from the ponds for a short period of time during the spring ice breakup.

Sludge disposal from the clarifier will continue as it is with sludge pumped to Pond 4 (23 acres), which has sludge holding capacity for an additional ten years. This pond will remain anaerobic and continue to give off odors.

As indicated elsewhere in this report, the major volume of wastewater is disposed of by seepage to the groundwater, which in turn reaches the river. The ponding system has been expanded as seepage has been reduced in the older ponds. HW is experimenting with rapid infiltration basins, which, if as successful as predicted by HW consultants, will permit ground disposal of the majority of the treated effluent. The proposed infiltration system would follow the aerated stabilization basins and settling ponds as described later in this report.

Under the proposed expansion program, a variety of measures would be taken to purify liquid effluents before they were discharged to the clarifier. These measures require technical explanation which will be furnished in Section II of this statement, where there is a further discussion of the proposed water pollution control techniques, and the types and amounts of pollutants likely to be generated.

The laws and regulations applicable to water quality can be found in Appendix B.

According to HW, the proposed expansion would require new installations in various parts of the plant, as follows.

WOODYARD

1. New hydraulic platform truck dumpers to replace the Number 1 and 2 cable hoist dumpers.

2. The pneumatic blowing systems, which take the chips from the truck dumpers and deliver them to storage or process, will have their capacities increased in order to reduce the cycle time per truck, and therefore meet the capacity requirements anticipated at peak unloading rates.

3. The increased utilization of sawdust pulp means that the outfeed system from the existing Atlas bin will need to be upgraded and its capacity increased to handle the projected design rates.

4. A new dump, storage area, and reclaim facilities for sawdust are planned in the northeast corner of the woodyard storage area next to Mullan Road.

5. The existing veneer chip reclaim system needs to be upgraded so that it will have the capacity to feed the digesters at the increased rate required for 1850 tons per day.

6. A tramp material separator system will be installed in line with the existing belt conveyor to the existing chip kamyr. This installation is required to protect the blow line refining system that will be installed as part of the pulp mill expansion.

7. The existing Atlas Sawdust Bin will be used for storage of pin chips, and the out-feed system changed to meet the new requirements.

8. A new access road to the new sawdust dumper is required within the plant grounds because the load restrictions on Mullan Road prohibit the travel of loaded chip trailers over its surface.

PULP MAKING

Changes in the pulping area include the following:

1. A new sawdust digester will be installed to produce about 275 tons of pulp per day. Relief gases from the digester will be routed through a turpentine condenser and then to the lime kiln.

2. A washing system will be installed for the sawdust pulp.

3. Blowline refining and additional washing facilities will be installed to increase yield and maintain minimum chemical losses.

4. Additional tankage for hi-density stock storage will be provided.

5. A knotter and two fibrilizers will be added to allow an increased pulping rate on the batch digesters.

6. An additional tank for storage of bleached pulp will be included. This bleached pulp will be used only to make spra-white linerboard.

PAPER MAKING

Market requirements indicate that the most efficient trim for linerboard is in multiples of 80." The expansion therefore includes a new No. 3 Paper Machine with a width of 320 inches. The machine would be a swing machine, capable of producing both linerboard and bag paper.

The No. 1 Paper Machine capacity will be expanded slightly by the addition of a high nip pressure press in the third position in order to meet the 1850 T/D goal.

STOCK PREPARATION NO. 3 PAPER MACHINE

This area includes stock chests required for the proper refining and blending of stocks; stock transfer pumps, consistency regulators; piping; white water system including savealls; and chemical additive system modifications.

NO. 1 PAPER MACHINE MODIFICATION

The modification required to enable No. 1 Paper Machine to meet the anticipated production goals for this machine at the 1850 T/D level of production are minimal in nature. They consist of substituting a new high nip pressure press, with its drive, in place of the existing No. 3 Press.

ROLL HANDLING AND WAREHOUSING

The existing warehousing and rail car loading dock would be demolished to make room for the No. 3 Paper Machine Building.

The facilities provided as part of the new expansion includes 48,000 square feet of net storage area, and provides the housing for the necessary roll lowering equipment to bring the rolls from the dry end of No. 3 Paper Machine to the loading docks.

LIQUOR EVAPORATION

The 1850 T/D level requires the addition of evaporators, condensers and tanks as well as extensive repiping. All noncondensible gases will eventually be channeled to one of the lime kilns for thermal oxidation.

RECOVERY BOILERS

The 1850 T/D production rate will require that the No. 2 Recovery Boiler be modified in order to meet the new emission standards and to burn the additional black liquor solids generated at this capacity. This modification would include an economizer and new precipitator. The electrostatic precipitator will be sized to meet the particulate emission standards.

STEAM GENERATION

A new steam generating boiler will be installed to provide the steam required using natural gas as the primary fuel. Additional feedwater treatment and auxiliary equipment would be installed as required.

EMERGENCY FUEL OIL SYSTEM

The growing shortage of natural gas and the increased need for fuel because of the increased expansion of production make it essential to install a new emergency fuel system. This system includes a 1,000,000 gallon fuel oil storage tank and an efficient unloading station. This large storage capacity will help insure HW's ability to purchase the required low sulfur oil when it is available.

RECAUSTICIZING

Expansion to 1850 T/D requires a complete recausticizing plant including a kiln, slaker, three causticizers, white liquor clarifier and mud washer. Included with the kiln will be a scrubbing and monitoring system as required by the Montana state emission standards.

RELOCATION AND DEMOLITION

The major items of relocation and demolition are as follows:

1. The new Kamyr Sawdust Digester necessitates the demolition of the existing lunchroom.
2. In order to make room for the new lime kiln, several tanks will be relocated. They will not be demolished since they were required for the new operation as well as the existing. A new chemical unloading station is also included, since the existing unloading station is in the way of the recausticizing expansion.

3. The addition of the No. 3 Paper Machine requires the demolition of the existing warehouse and rail car loading docks.

ELECTRICAL DISTRIBUTION

The necessary electrical distribution equipment as well as the secondary wiring required for the mill expansion will be installed.

SEWERS

The existing sewers will be relocated and new sewers constructed as necessary to provide adequate service to the new facilities. All sewers would enter the existing effluent system ahead of the clarifier.

GAS FACILITIES

Included is a new gas line to the new boiler location and rework and relocation of the gas lines necessary to service the new lime kilns.

WATER SUPPLY

Four new wells are required. The increase in pumping rate through the existing pipe line will increase the friction to the point that it will be necessary to upgrade the existing pumps to increase their maximum potential head.

FIRE PROTECTION

The underground fire protection main which loops the existing mill facilities will require extensive relocation. Installing sprinklers in the new paper machine and warehousing buildings is also included in the project.

EFFLUENT TREATMENT

The modifications to the existing mill facilities required to achieve the desired mill production expansion will result in a much lower loss of solids and BOD per ton of production than is currently being experienced. It is anticipated that total pounds per day of suspended solids and BOD entering the clarifier will be no higher than from the existing operation.

A commitment has been made to the state and federal agencies that additional treatment capability will be added in 1975 to reduce the current BOD load to the river. This installation would be sized for the expanded mill.

The effluent treatment system is therefore based upon a continuation of the present practice of ponding effluent and discharging directly to the river only during the 6 to 8 weeks spring runoff period. The mill, assuming that some minimum seepage rate can be maintained, has calculated that approximately 325 additional acres of ponds may be required to handle the 5.8 million gallon increase of daily effluent volume.

No additional primary clarification is required since the anticipated load to the clarifier will not exceed the capacity of the existing clarifier.

RAILROAD

The existing plant site facilities include a rather extensive system of tracks used for marshalling the cars. The addition of the No. 3 Paper Machine Building has required the elimination of many of these tracks; therefore, there is an extensive amount of track work included in the expansion to provide access to the woodyard as well as to the roll shipping dock.

II. DESCRIPTION OF PLANT AND PROCESS

A. Basic Manufacturing Process

The Kraft or sulfate method of paper making used by HW is forecast to remain the most popular of the various processes. The groundwood, semi-chemical (NSSC or neutral sulfite semi-chemical pulping), soda, and sulfite processes accounted for less than 29% of the 1964 wood pulp production of 32,428,000 tons in the U.S. (3). In the U.S. in 1970 these methods accounted for less than 10% of the 36,400,000 ton production. (4)

Only the Kraft process used by HW at Missoula will be discussed in this statement. The Kraft process uses an alkaline solution of sodium hydroxide (NaOH), sodium sulfide (Na_2S) and sodium carbonate (Na_2CO_3) for cooking, or digesting wood chips to a pulp suitable for paper manufacture.

Raw materials for the plant are obtained either in the form of sawmill waste or directly from the forests as roundwood. Most of the pulp is produced from chips from sawmill residues although a lesser amount of roundwood is used. HW uses some sawdust and the proposed expansion would use an increased percentage of sawdust as raw material. When roundwood is used, it must be chipped before it enters the paper making process.

The raw materials are introduced into digesters and white or cooking liquor is added. The liquor removes the lignins from the wood leaving a fibrous cellulose pulp. After digestion the pulp is washed to remove the cooking chemicals and dissolved organics and transported to the paper machines. The wet pulp is dewatered mechanically and thermally and pressed into a continuous belt of Kraft linerboard paper.

After leaving the digesters, the pulp is washed, producing a relatively dilute stream of chemicals in a solution known as weak black liquor. The weak black liquor containing about 15% solids is concentrated by the evaporation of water to produce strong black liquor. Black liquor contains large quantities of organics (lignins) dissolved from the wood. The heat value of the lignins is extracted by burning the liquor in recovery furnaces where the non-combustible chemicals are melted and recovered as smelt. The smelt is dissolved and makeup chemical added to form green liquor. The green liquor is further processed chemically and mechanically to regenerate the white cooking liquor. Figure 1 illustrates the Kraft pulping process for HW's expanded mill with emission figures as related in HW's most recent permit application.

DETAILED DESCRIPTION

HW employs two digesting methods-continuous and batch. In the batch process, the digesters are sequentially filled, cooked and emptied.

Only chips are batch digested with 1260 tons per day (TPD) charged into the 8 cylindrical mild steel digester vessels. After the chips are charged, cooking liquor, a solution consisting principally of $NaOH$ and Na_2S with varying amounts of Na_2CO_3, sodium sulfate (Na_2SO_4), sodium sulfite (Na_2SO_3) and thio-sulfate ($Na_2S_2O_3$), is added, and live steam is introduced after the vessel is closed. Cooking is carried out at about 340^oF and 100 psig for about four hours.

At the end of the cook, the contents of the digester are "blown" into a tank. A considerable amount of steam flashes off along with some odorous gases. These gases are vented to an accumulator which is a large tank containing cold water and a large vapor space. The accumulator serves to reduce the volume of digester blow gases and condenses some of the odorous compounds, prior to transport of the gases to the lime kiln for incineration.

Besides its batch digesters, HW has two continuous digesters, one of which can produce up to 900 TPD (dry weight) of pulp, and the other up to 150 TPD. These two digesters together can process up to 3200 TPD of chips (wet weight). The expansion would add a 275 TPD digester which could process up to 1430 TPD of wet sawdust.

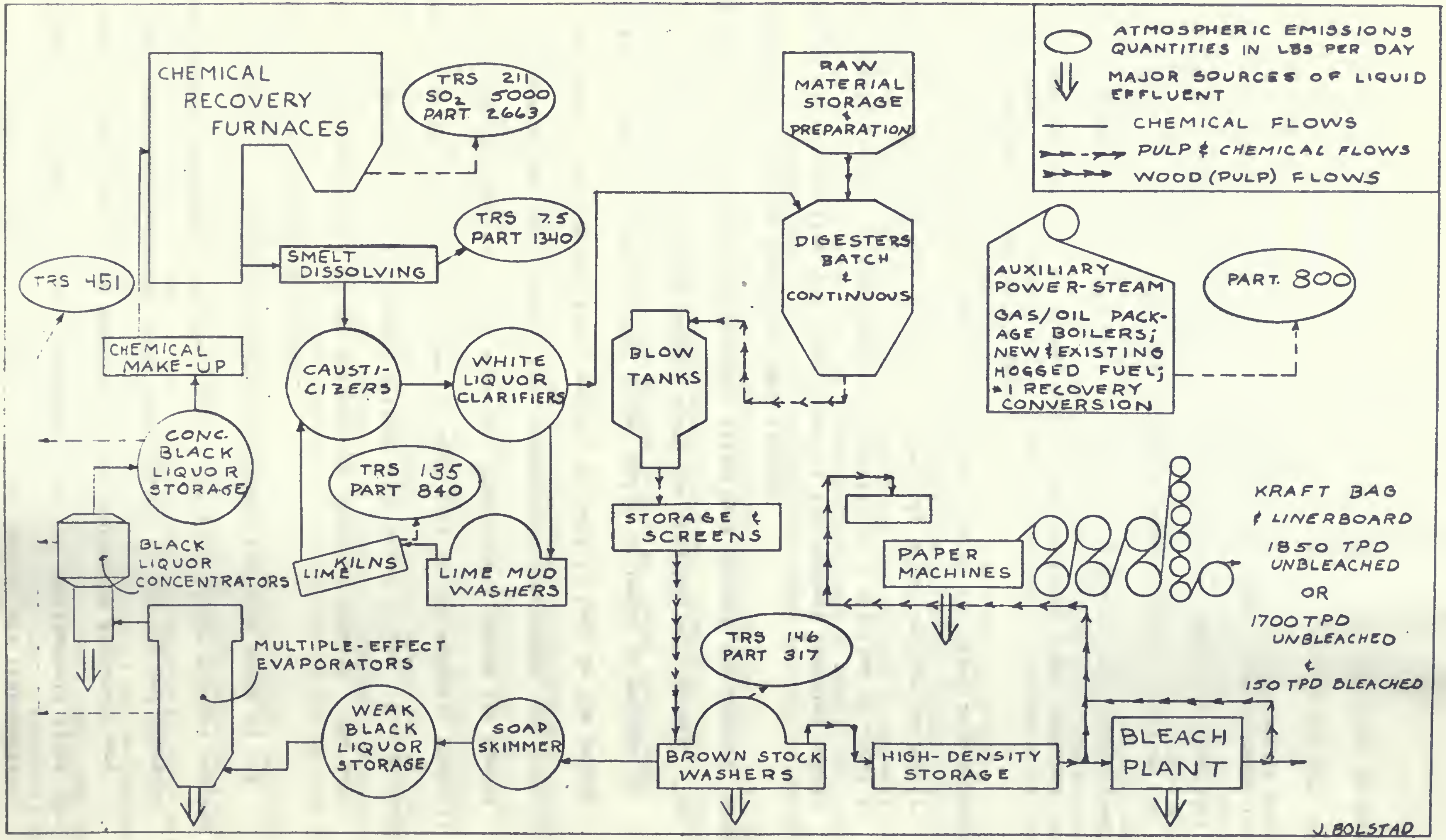


FIGURE 1

SIMPLIFIED MILL FLOW DIAGRAM – HOERNER-WALDORF

In the continuous digester process chips and sawdust are transported pneumatically to screening units, presteamed, and fed continuously along with white liquor to the tops of the digesters. The continuous digesters are always full, with fresh material added continuously to the top and digested pulp continuously withdrawn from the bottom. The pulp-liquor mixture removed from the bottom of the continuous digesters follows the same route as the digested pulp from the batch digesters.

It is first transported to the washers for chemical removal. The pulp washers are a series of rotary vacuum filters with water sprays. Contaminated condensate from the evaporators is used to wash pulp in the washers, where it first enters the last washer in the sequence, from whence issues the washed pulp. After use in the last washer, the contaminated condensate, now dirtier than it was when it entered the first washer, is used in turn in the second to last stage, then the third to last stage, and so on until it emerges as weak black liquor from the first washer where the unwashed pulp enters. The pulp and wash water thus move in opposite directions through the washers, with the one getting dirtier as the other gets cleaner.

The liquor issuing from the first stage of the washers contains nearly all the chemicals used plus the dissolved organics in a solution of about 15 percent solids. The chemicals retained in the pulp after washing currently consists of about 30 pounds of Na_2SO_4 (soda) per ton of air dried pulp produced (TADP), with another 30 lost in the water.

After washing, the pulp is transported to one of three paper machines and diluted to ½ percent solids. The pulp is placed on a moving wire screen where much of the water is drained off. The partially dewatered pulp still on the screen is fed to a series of steam heated roller presses, where the remainder of the water is driven off and the pulp becomes Kraft paper which is wound on rolls for shipment.

The remainder of the plant is largely devoted to recovering chemicals from the weak black liquor. Chemical costs are one of the major expense of paper production, so it is economically desirable to minimize chemical losses.

Weak black liquor from digesting is collected from the brown stock (pulp) washers and from the flash tank on the 900 TPD Kamyr continuous digester. At this point the liquor contains about 13-16% black liquor solids (chemical and organic) and is fed to the multiple effect evaporators. These evaporators contain several consecutive stages or "effects" for evaporation to achieve optimum use of the steam, which supplies the heat to evaporate the water. Additional evaporation is obtained by varying the pressure (vacuum) of the various effects to alter the boiling point of the black liquor. The product of the evaporators is strong black liquor containing 40 to 45 percent black liquor solids.

The strong black liquor is stored and fed to the concentrators for further dewatering. This additional dewatering is needed as the black liquor will not burn until the solids concentration reaches 60-62 percent. The concentrators operate in the same manner as the multiple effect evaporators.

After the liquor is concentrated enough to be combustible, it is stored to await burning in the recovery furnace. From the storage tanks, the liquor is fed to mix tanks, where makeup chemicals are added. Purchased salt cake (primarily Na_2SO_4), fly ash from the precipitator (also Na_2SO_4), and caustic are added as necessary to give the proper chemical composition to the white liquor which will eventually result from combustion of the black liquor. After the chemicals are added, the black liquor is sprayed into the recovery furnace where the organic wood products burn and the inorganic chemicals melt and fall to the bottom of the furnace. At present, 3.19×10^6 pounds of black liquor solids are fired each day and the expanded mill would burn about 4.87×10^6 lbs/day. The furnace also serves as a boiler, and considerable heat is extracted as steam from the combustion process. The inorganic chemicals are tapped continuously, as smelt, from the furnace bottom into smelt dissolving tanks. The smelt, mostly Na_2CO_3 and Na_2S, is dissolved in wash water from the lime kiln mud washers. The resulting green liquor is clarified and stored for future processing.

The green liquor eventually is causticized with slaked lime ($Ca(OH)_2$) to regenerate the sodium compounds in the chemical forms needed for digestion. Sodium carbonate, one of the recovery furnace products, is converted to sodium hydroxide by the lime in the causticizing process. The resulting white liquor is clarified to remove the undissolved ($CaCO_3$) solids, after which it is ready for reuse in the digesters. The $CaCO_3$ is washed, dewatered, and fed to the lime kiln for regeneration to CaO. The wash water is used for smelt dissolving.

Ancillary mill facilities include the bleach plant, power boilers, turpentine condensers, tall oil reactor and water treatment systems.

The bleach plant is used only for a small portion of the total pulp produced.

The power boilers produce steam to supplement that produced by the recovery furnaces. HW's expansion proposal includes provisions for conversion of the #1 recovery boiler to a power boiler and addition of one new power boiler fired by hogged fuel and gas or oil.

The turpentine condenser processes overhead vapors from the digesters and evaporators to produce marketable turpentine.

The tall oil reactor uses soaps removed from the black liquor as feed stocks to make tall oil, a mixture of rosin acids and fatty acids, used in making paint, alkyd resin, linoleum and many other materials.

B. Sources and Nature of Pollution

AIR POLLUTION

Nearly every item of process equipment in a pulp and paper mill can contribute to pollution of air and water. Air pollutants generated in the pulping process are many and varied. Gases and particulates are emitted as a variety of compounds. Many of the gaseous emissions are odorous, among them hydrogen sulfide (H_2S), methyl mercaptan, (CH_3SH), dimethyl sulfide (CH_3SCH_3) and dimethyl disulfide (CH_3SSCH_3). Other gaseous pollutants emitted are sulfur dioxide (SO_2) and carbon monoxide (CO). Particulate emissions include wood fiber, sodium compounds from the recovery furnaces, fly ash, and calcium compounds. Table 1 summarizes the various pollutants and sources.

a. Particulate

1. Wood Fiber

Emissions of wood fiber occur during the first steps in the plant operation. Wood dust is generated when chips, sawdust and roundwood are brought to the plant by truck and rail, dumped and transported to storage. Debarking and chipping of roundwood generates more particulate, and the cyclonic collectors in the pneumatic conveying system allow fine wood particles and dust to escape to the atmosphere.

Venting of the pulp washers entrains pulp and wood fiber which are emitted to the atmosphere through the vents. The paper machine vent gases contain wood fibers generated in a similar manner.

2. Fly Ash

Fly ash emissions result from fuel combustion and consist of the non-combustible or inorganic material contained in the fuel. Particles of partially burned fuel (sometimes referred to as soot or cinders) also may be considered fly ash.

Combustion of natural gas, the normal fuel for the lime kilns and power boilers, results in very little emission of fly ash. EPA states (5) that

Table 1

	GASES						PARTICULATES			
	$N(O)_x$	SO_2	H_2S	CH_3SH	$(CH_3)_2S$	CH_3SSCH_3	Wood Fiber Paper	Fly Ash	Calcium	Sodium
Raw Materials Handling							X			
Digesters			X	X	X	X				
Pulp Washers			X	X	X	X	X(T)			
Bleach Plant										
Paper Machines							X(T)			
Evaporators/Concentrators			X	X	X	X				
Turpentine Condenser			X	X	X	X				
Tall Oil Reactor			X	X	X	X				
Recovery Furnaces	X	X	X	X	X(N)	X(N)		X		X
Smelt Tanks		X(T)								X
Lime Kilns			X						X	X
Slakers									X	X
Hog Fuel Boiler	X						X	X		
Gas/Oil Boilers	X	X						X		

(T) Trace

(N) Negligible

natural gas combustion will emit 18 pounds of particulate per million cubic feet (#/10^6 Ft^3) of natural gas burned. For HW at normal consumption rates this would be about 0.8 #/hr. Fuel oil combustion can result in significant quantities of fly ash emission if combustion controls are improperly adjusted or malfunctioning. Good operation of the equipment still results in particulate emission. EPA emission factors for distillate oil combustion are 18 # of particulate per 1000 gallons (#/10^3 gal) of oil burned, which during natural gas curtailments at HW would result in emissions of 28.8 #/hr. At HW's stated maximum firing rate (80 gallons/minute (GPM), 86.4 #/hr of particulate emission might result. If this emission rate continued for 24 hours, the total emission might reach 2074 #.

Other emissions of fly ash issue from the hogged-fuel (waste wood) boiler. According to HW, the existing unit emits some 200 #/day of particulate.

3. Calcium Compounds

The two major sources of particulate calcium are the lime kilns and the slakers. The slakers convert the kiln product--calcium oxide (CaO)--to calcium hydroxide ($Ca(OH)_2$) and approximately 210 #/day (6) are emitted, presumably as CaO and $Ca(OH)_2$.

The lime kilns, which process calcium carbonate ($CaCO_3$) to CaO, would be expected to emit mostly these two compounds. However, limited testing, by SDHES, confirmed by HW testing, indicates that much of the particulate is some form of sulfate, apparently sodium sulfate (Na_2SO_4). The kilns currently emit about 520 #/day particulate.

4. Sodium Compounds

The largest source of sodium emission are the recovery furnaces. Nearly all the particulate emitted is Na_2SO_4, with small amounts of Na_2CO_3. Total emission here is currently 1975 #/day (7). The quantity of emission from these furnaces is dependent on many ill-defined furnace and process parameters. Maintenance and proper operation of the electrostatic precipitator is most important in controlling recovery furnace emissions.

The smelt tanks are another source of sodium emissions as Na_2CO_3 and Na_2S, and currently emit 1235 #/day of total particulate. Emissions from the smelt dissolving tank are caused as the molten smelt is tapped from the recovery furnace into water. The ensuing violent reaction between the hot smelt and water entrains some smelt in the off gases.

As previously mentioned, the lime kilns are an additional source of sodium particulate. Very limited state testing indicates Na_2SO_4 calculated from sodium is between 19.6 and 43.9% of the total kiln emissions of 520 #/day (6). HW testing indicates the percentage is between 50.5 and 100.

b. Gases

1. Reduced Sulfur

Until very recently, odorous gases received higher pollution control priority than any other pulp mill emission. These gases are nearly all sulfur compounds, with the sulfur in a reduced state; hence, the term "reduced sulfurs." The most significant reduced sulfur compound at HW is H_2S. Also occurring to lesser extents are the sulfur compounds mentioned at the beginning of this section. The perception of odor due to these chemicals varies--Table 2 gives the odor threshold for the most commonly found gases:

Table 2 --Odor Thresholds (4)

Compound	Concentration-PPB
H_2S	4.7
CH_3SH	2.1
CH_3SCH_3	1
CH_3SSCH_3	5.6

The odorous gases are created by the reactions between liquor sulfur chemicals and wood lignins, primarily in the digesters. As pulp is being cooked, gases containing sulfides and mercaptan are bled off to maintain the proper pressure and temperature in the vessels. These overhead vapors are collected and vented to the turpentine condenser for recovery of organic by-products. When the batch digester charge is cooked, it is emptied into a tank (or "blown"). Large volumes of steam and odorous gas are released and vented to a condenser and accumulator for reduction of volume. The remaining non-condensibles are vented to the lime kiln for incineration.

Off gases from continuous digestion are treated in much the same manner with the addition of vapors from the steaming vessel.

As the pulp is washed on the vacuum washers TRS is liberated. The washers are hooded and ducted to remove TRS and water vapor to the atmosphere. About 91 #/day TRS issue from this source. HW originally intended to incinerate this TRS in a boiler but abandoned the idea because of cost, and then again decided to go ahead.

The pulp washer filtrate contains most of the chemicals used in the process and most of the organics removed from the wood. This weak black liquor is evaporated and concentrated as previously described. The water driven off contains significant quantities of TRS. After passing through condensers after each evaporation sequence, significant quantities of TRS remain uncondensed. These gas streams vent to the accumulator-turpentine system with final disposition in the lime kilns. Odorous non-condensible gases from the concentrator vent to the same system. Additional concentrator gases generated in the expanded mill also would be incinerated in the lime kiln.

The lime kilns emit TRS as a result of dissolved sulfide in the mud slurry and the use of the kilns as incinerators. Current emissions average 234 #/day from the three kilns.(6)

The condensates from the various systems pass to a sewer. In the sewer, dissolved TRS compounds are liberated to the atmosphere as a result of air contact and pH changes. Further emission occurs at the effluent treatment system. HW has determined that the condensates cause emission of 1600 #/day of TRS in the mill and 1200 #/day at the wastewater treatment ponds. (6)

The greatest single source of odor apparently is the pond system itself. The effluent discharged to the system contains on the average 1340 #/10^6 gal. of dissolved sulfur as sulfates. The pond system in general is anaerobic (oxygen deficient) and in this situation certain bacteria types are active. These bacteria reduce the sulfate compounds to sulfides by removing the chemically bound oxygen for use in respiration. According to HW the product of the respiration is 17,000 pounds/day of H_2S, which goes to the atmosphere. As noted previously, HW has undertaken a program to aerate the ponds and raise their oxygen content enough to make them aerobic, thus preventing the reduction of sulfate to H_2S and diminishing the odor.

The concentrated black liquor is delivered to the recovery furnaces for burning of the organics and recovery of cooking chemicals. The recovery furnaces were at one time the major source of pollution from Kraft pulp mills. They remain the major source of particulate matter but not of TRS, at least at the HW plant. At an average of 5 ppm TRS as H_2S in the flue gas, HW's two recovery furnaces emit 135 #/day. This compares with 1970 emissions of 11,340 #/day at HW.

2. Sulfur Dioxide

Sulfur dioxide emissions resulting from conversion to low odor furnaces are a recent addition to Kraft pulp mill pollution, although SO_2 has always been emitted when power boilers are fired with fuel oil. SO_2 emission from recovery furnaces are highly dependent on the sulfidity (a ratio of $Na_2S/Na_2S + NaOH$) of the liquor. The relationship is direct and sulfidity changes of a few percent (eg 29 to 27) can reduce SO_2 emissions by a factor of 4. If, for example, the SO_2 concentration in the flue gas is 100 ppm, 5410 #/day SO_2 would emit from the current mill. At 25 ppm, one fourth of this amount or 1353 #/day would exit the stacks of recovery boilers Nos. 3 & 4. Furnace operating variables also can affect SO_2 emissions, but these relationships are poorly understood.

Other possible sources of sulfur dioxide are the power boilers. Some of these boilers are equipped to fire either natural gas or fuel oil. Natural gas combustion results in essentially no SO_2 emission. HW has said that the boilers equipped to burn oil can do so at a maxiumu firing rate of 80 GPM. If these units were burning oil containing the maximum amount of sulfur allowed by Montana APC regulations, they could emit over 32,000 # of SO_2 per day. As previously stated in the section on particulates, fuel oil combustion is likely to occur only during curtailments of natural gas. Further discussion of this problem may be found later under Alternate Air Pollution Control Strategies.

3. Nitrogen Oxides

Nitrogen oxides (NO_x) are formed during high temperature combustion processes by the reaction of atmospheric nitrogen and oxygen. The normal oxide of nitrogen emitted from a combustion process is nitrogen oxide (NO). The other specie, which enters into the "smog reactions," is nitrogen dioxide (NO_2). Furnace conditions favor the emission of NO rather than NO_2. NO is oxidized in the atmosphere to NO_2.

Due to the low furnace temperature, Kraft recovery boilers are not a significant source of NO_x. Comments on the draft EIS indicate however, that HW's recovery boilers may indeed be significant sources of NO_x, and that when added to estimates of NO_x emitted from the hogged fuel boilers and power boilers, recovery boiler NO_x might boost total mill emissions to almost 20,000 #/day (8) of NO_x, compared to other valley emissions of about 50,000 #/day (9).

At normal furnace temperatures, however, (about 2400°F max.), little NO is expected to form. EPA's predecessor, NAPCA, said: "below 2800°F, formation is negligible. . .." (10) A rough estimate is that at 2400°F, the flue gas might contain 10 ppm NO_x, which would result in an emission of about 300 #/day.

WATER POLLUTION

There are three major pollutants in the wastewater from the pulp, paper, and bleach plant. These are the biochemical oxygen demand (BOD), which is a measure of the oxygen required to biologically stabilize the organic materials, total suspended solids (TSS), which are the solids that can be removed by filtration, and color. BOD is usually expressed in terms of five-day BOD (BOD_5). Color bodies in wastewaters from pulp and paper mills are lignin-like in character and are reported to be lignins which have been degraded to various degrees.

The major sources of BOD are the pulp washing operation, evaporator condensates, and spills and overflows. The actual papermaking stage of the process causes little BOD, and almost all the BOD in the effluent from the papermaking process is that which was not removed in the pulp washing process.

To assist the EPA in the preparation of its Development Document (1), four unbleached pulp and paper mills were surveyed to determine their pollution control efficiency. The mills picked for the survey were ones with low discharge flows and low discharges of treated BOD and suspended solids. Each of the mills surveyed had raw (untreated) wastewater discharges of 9,500 to 13,500 gallons per ton, BOD_5 of 27 to 31 pounds per ton, and TSS of 21 to 56 pounds per ton. One of the four mills surveyed had a color of 567 units and another measured 286 units on a short term test.

In the state of the art review (11) "high bleaching" is reported to produce an effluent of 25,000 to 35,000 gallons per ton of product, 40 to 60 pounds of BOD_5 per ton, 20 to 30 pounds TSS per ton, and a color of 4,000 to 6,000 units. The color units calculate to 833 to 1,750 pounds per ton if it is assumed that the higher units could occur with the higher flows and the lower units could occur with the lower flows. For purposes of calculation only, so as to enable use of a total combined flow and color units to obtain a mass balance, one color unit is assumed to equal one milligram per liter.

An average of 159 tons (based on 350 operating days) of bleached product was produced in 1973 by HW. HW reports 30,000 gallons of water are required per ton of bleached product. The discharge from the bleach plant would, therefore, average 4.8 million gallons per day (MGD). The total contaminated waste flow (not including the uncontaminated cooling water which is discharged separately) averaged 15.8 mgd. HW reported an average of 1,187 tons of pulp was produced per day based on 350 operating days. HW assumes the use of 10,000 gallon per ton for the unbleached pulp and paper operation and 4,000 gallons per ton for pulp production alone.

Bleaching is reported by HW to contribute 31 pounds of BOD_5 per ton of bleached pulp. For 1973, BOD from the unbleached portion of the pulp and paper mill operation averaged 56 pounds BOD_5 per ton of pulp. Assuming 30 pounds of TSS per ton of bleached pulp, the average for the unbleached portion of the mill is 36 pounds per ton of pulp. The daily contribution of BOD and TSS is highly variable; mainly because of spills and overflows.

The principal source of color is the bleaching operation, even though a relatively low tonnage of bleached product is produced. Using an average color value of 3,000 units with a total wastewater flow of 15.8 mgd gives a total color of 395,000 pounds per day produced by the mill. HW reports that 1,900 pounds per ton of color of bleached product or 302,000 pounds per day are produced by the bleach plant. The color from the unbleached pulp and paper operation is, therefore, estimated at 93,000 pounds per day (78 pounds per ton).

C. History of Pollution and Control at Hoerner-Waldorf

AIR POLLUTION CONTROLS

HW's pulp and paper mill was built in 1957. The plant initially consisted of three batch digesters and the #1 recovery furnace, equipped with a wet scrubbing system that could collect 88-90 percent of particulate. In 1958, another batch digester was added. In 1959 the #2 furnace was added and equipped with an identical air pollution control system (APC). Two more batch digesters and the #2 lime kiln were added the same year. A hog fuel boiler was installed in 1963.

In 1964, HW installed a black liquor oxidation system in an attempt to reduce odorous emissions from the recovery furnaces. A venturi scrubber replaced a less efficient scrubber on the lime kilns and an incineration system was added for some of the non-condensible gas streams. Another batch digester was put on stream that year.

The mill was expanded in 1966 with the addition of the #3 recovery boiler and the sawdust and Kamyr digesters. The furnace was equipped with the same APC equipment as 1 and 2, plus an additional venturi. All furnaces used a "direct contact evaporator" permitting gas contact and subsequent stripping of odorous compounds from the black liquor. Black liquor oxidation used at HW to fix the sulfur compounds and prevent their stripping was the standard odor control method in U.S. mills.

In early 1968 the "low-odor" recovery boiler system arrived and on November 5, 1969, HW announced Phase I of its APC program which was based on the conversion of its #3 recovery boiler to the low odor system. In early 1970, prior to the proposed modifications, total air pollutant emissions from the plant were estimated as follows.

TRS = 11,600 #/day

SO_2 = 0

Total Particulate = 41,490 #/day

It seems that the TRS data were not quite correct, as HW now calculates an additional TRS emission of about 19,805 #/day from the ponds and foul condensates.

In May, 1970, HW presented its Phase II plan for replacement of No. 1 and 2 furnaces with a new low odor #4 boiler.

Construction for Phase I began in March of 1970 and was completed May, 1971. Phase II was commenced February, 1971, and completed a few months ago.

Wet scrubbers were installed on the slakers, reducing particulate emission from 9260 #/day to 130 #/day and on the hogged fuel boiler reducing particulate from 8700 #/day to 200 #/day. HW testing indicates that total plant emissions currently are as follows, including TRS from the ponds.

TRS = 20,376 #/day

SO_2 = 5000 #/day

Particulates = 5414 #/day

Table 3 lists all inventoried emission sources and their daily total emissions from the present mill.

HW has undertaken additional control programs--the most notable being the secondary treatment of the ponds--designed to further reduce emissions. These programs will be implemented regardless of whether the plant expands. Table 4 presents projected data for the mill with control programs implemented but no expansion. Table 5 represents projected emissions for the mill as the expansion is presently proposed.

TABLE 3

CURRENT EMISSIONS

Pollutant Source	TRS #/day	SO_2 #/day	Part. #/day
#2 recovery boiler	0	1250	0
#3 recovery boiler	55	to	1075
#4 recovery boiler	80	5000	890
Brown stock washers	91	0	984
#1 lime kiln	62	0	90
#2 lime kiln	62	0	250
#3 lime kiln	110	0	180
#4 lime kiln	0	0	0
#1 and 2 slaker		0	65
#3 slaker		0	65
#4 slaker		0	0
#2 smelt dissolving tanks	0	0	0
#3 smelt dissolving tanks	2.3	0	870
#4 smelt dissolving tanks	2.4	0	290
Foul condensate streams	2,805		
Ponds	17,000		
Tall oil reactor	88		
Existing wood boiler	0	0	200
New wood boiler	0	0	0
#1 recovery - power			
Existing package power			
Raw materials conveying system	0	0	445
Miscellaneous odor sources	18.5		
	20,376	1250 to 5000	5414

TABLE 4

FUTURE MILL, NO EXPANSION

Pollutant Source	TRS	SO_2	Part.
#2 recovery boiler	0	1250	0
#3 recovery boiler	55	to	1085
#4 recovery boiler	80	5000	890
Brown stock washers	91	0	984
#1 lime kiln	62	0	90
#2 lime kiln	62	0	250
#3 lime kiln	110	0	180
#4 lime kiln	0	0	0
#1 and 2 slakers	0	0	65
#3 slakers	0	0	65
#4 slakers	0	0	0
#2 smelt dissolving tanks	0	0	0
#3 smelt dissolving tanks	2.3	0	870
#4 smelt dissolving tanks	2.4	0	290
Foul condensate streams	2805	0	0
Ponds	404	0	0
Tall oil reactor	1	0	0
Existing wood boiler	0	0	200
New wood boiler	0	0	0
#1 recover - power			
Existing power			
Raw materials conveying system			445
Miscellaneous odor sources	18.5	0	0
	3693	1250 to 5000	5414

TABLE 5

EXPANDED MILL AS PROPOSED

Pollutant Source	TRS #/day	SO_2 #/day	Part. #/day
#2 recovery boiler	39	1990	410
#3 recovery boiler	55	to	1085
#4 recovery boiler	117	5000	1253
Brown stock washers	146	0	317
#1 lime kiln	25		90
#2 lime kiln	25		250
#3 lime kiln	44		180
#4 lime kiln	51		320
#1 and 2 slaker			65
#3 slaker			65
#4 slaker			80
#2 smelt dissolving tank	2.2		120
#3 smelt dissolving tank	2.3		870
#4 smelt dissolving tank	3.0		350
Foul condensate streams	451		
Ponds	404		
Tall oil reactor	1		
Existing wood boiler	0	0	200
New wood boiler	0	0	600
#1 recovery - power			
Existing package power			
Raw materials conveying system			271
Miscellaneous odor sources	23.5		
	1389	1990 to 5000	6526

WATER POLLUTION CONTROLS

The existing plant wastewater disposal system and the proposed system are schematically shown in Figure 2; Figure 3 is a map of the area. In the existing treatment system, a mechanical clarifier removes about 65 percent of the suspended solids and 96 to 98 percent of the settleable solids. Sludge from the clarifier is pumped to Pond #3 and #4. Little BOD is removed in this operation. The clarified effluent enters the shallow ponds which act as stabilizing basins. The clarifier and ponds reduce the BOD_5 concentration from about 560 mg/l to 300 mg/l by the time it reaches the lower ponds. The average BOD_5 concentration of all the ponds is somewhere between these two values.

The main portion of the BOD_5 reduction occurs as the effluent percolates through the pond bottoms and travels through the groundwater system. On the basis of groundwater samples obtained from test wells located between the ponds and the river, it is calculated that the BOD_5 concentration is reduced about 90 percent by the combination of pond storage and seepage.

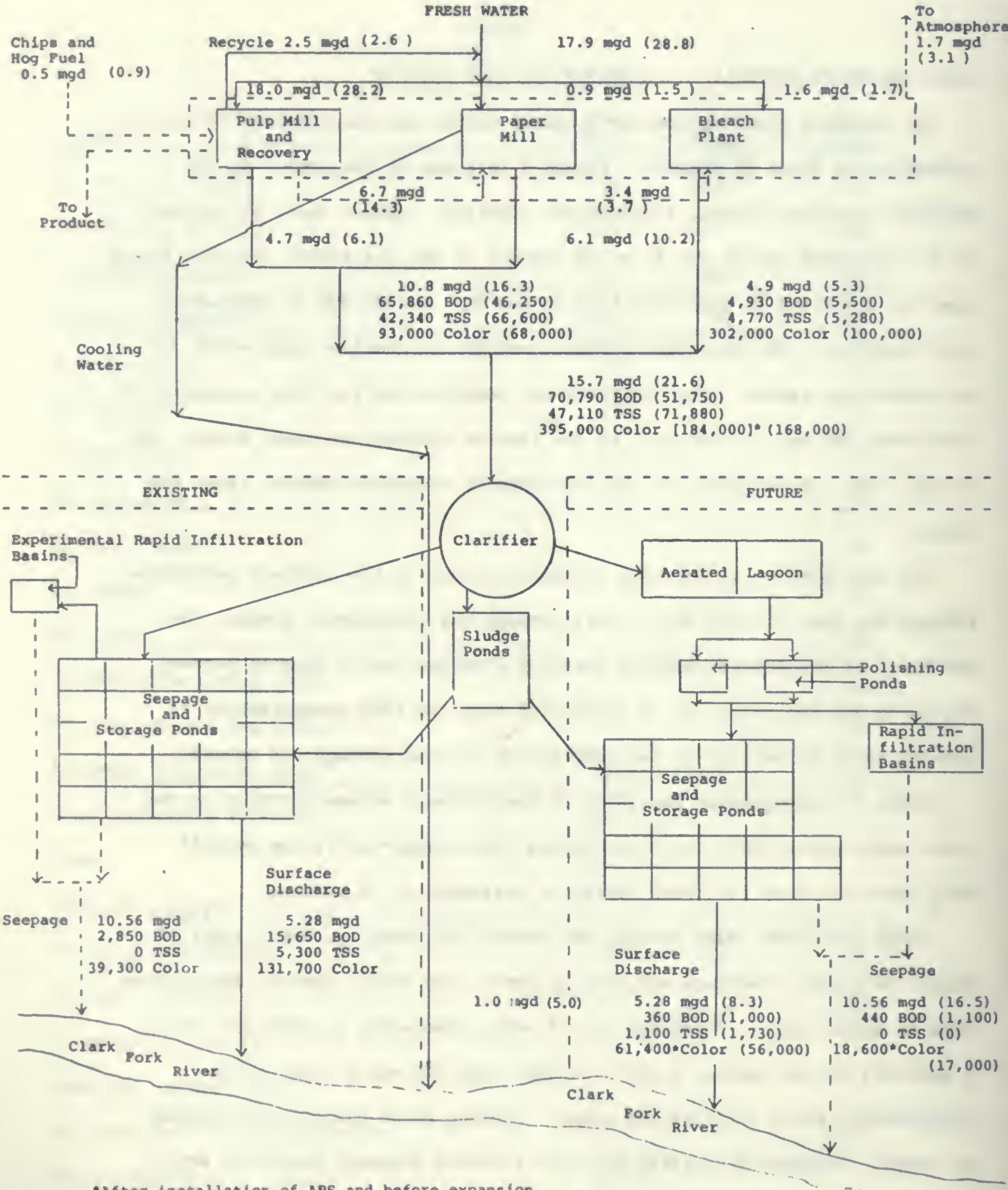
After releasing about one-third of the effluent volume directly to the river under controlled conditions during the spring runoff, the overall BOD_5 reduction from the total system is estimated at 74 percent.

Ponds have been added through the years, and there are now a total of about 750 acres of storage and seepage ponds with liquid depths ranging from four to twelve feet. Ponds #14 and 15 were constructed in 1970 and 1971. A majority of the seepage occurs through Ponds #14 and 15 and the two experimental rapid infiltration ponds. Ponding alone essentially removes no color. Problems associated with the existing disposal operation are:

1. Present ponds are anaerobic which leads to hydrogen sulfide odors.
2. The percolation through the pond bottoms gradually decreases with time so that construction of new ponds is required periodically.

FIGURE 2

WATER USAGE - WASTEWATER FLOW DIAGRAM



*After installation of APS and before expansion.
All values for BOD, TSS and Color in pounds per day.

NOTE: Numbers in parentheses are for the expanded mill. Numbers for the existing operation reflect values for 1973. All numbers are based on 350 days per year and disposal of one-third by direct discharge and two-thirds by percolation.

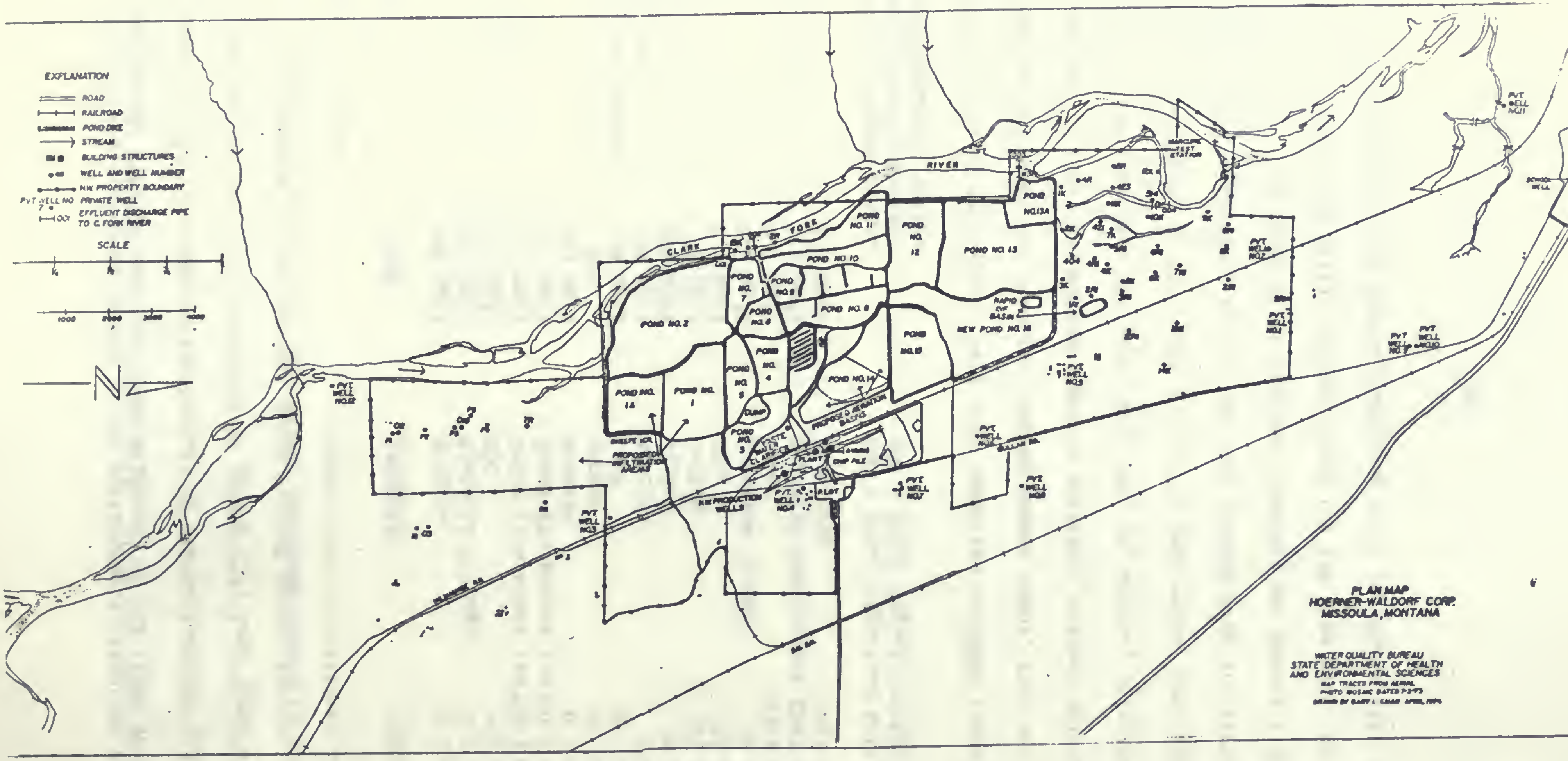

EXPLANATION
ROAD
RAILROAD
POND DIKE
STREAM
BUILDING STRUCTURES
WELL AND WELL NUMBER
H-W PROPERTY BOUNDARY
PVT WELL NO 7 PRIVATE WELL
001 EFFLUENT DISCHARGE PIPE TO C. FORK RIVER
SCALE
1/4
1/2
3/4
1
1000
2000
3000
4000
N
CLARK FORK RIVER
POND NO. 1
POND NO. 2
POND NO. 3
POND NO. 4
POND NO. 5
POND NO. 6
POND NO. 7
POND NO. 8
POND NO. 9
POND NO. 10
POND NO. 11
POND NO. 12
POND NO. 13
POND NO. 13A
POND NO. 14
POND NO. 14
POND NO. 15
NEW POND NO. 16
RAPID INF BASIN
PROPOSED AERATION BASINS
PROPOSED INFILTRATION AREAS
WASTE WATER CLARIFIER
CLAMP
PLANT
CHIP PILE
P. LOT
H-W PRODUCTION WELLS
MARCURE TEST STATION
SCHOOL WELL
PVT WELL NO. 1
PVT WELL NO. 2
PVT WELL NO. 3
PVT WELL NO. 4
PVT WELL NO. 5
PVT WELL NO. 6
PVT WELL NO. 7
PVT WELL NO. 8
PVT WELL NO. 9
PVT WELL NO. 10
PVT WELL NO. 11
PVT WELL NO. 12
MILWAUKEE RR
DALLAS RR
PLAN MAP
HOERNER-WALDORF CORP.
MISSOULA, MONTANA
WATER QUALITY BUREAU
STATE DEPARTMENT OF HEALTH
AND ENVIRONMENTAL SCIENCES
MAP TRACED FROM AERIAL
PHOTO MOSAIC DATED 7-3-73

Figure 3

3. The existing treatment system is not sufficiently effective to allow the present mill to meet the color standards on the Clark Fork River.

The values listed below are average values of the wastewaters discharged from the ponds during 1971 as reported by HW on the U.S. Army Corps of Engineers Application Form 4345-1. The values indicated should be about the same at this time.

Parameter	Value	Parameter	Value
BOD_5	306 mg/l	Nitrite	0.1 mg/l
COD	1497 mg/l	Kjeldahl Nitrogen	4.3 mg/l
Total Solids	2360 mg/l	TOC	992 mg/l
TVS	1122 mg/l	Ortho Phosporous (as P)	0.3 mg/l
TSS	97 mg/l	Total Phosporous (as P)	0.7 mg/l
TDS	2263 mg/l	Bromide	0.2 mg/l
pH	8.0	Copper	20 ug/l
Alkalinity (as $CaCO_3$)	678 mg/l	Lead	0.1 mg/l
Oil and Grease	38 mg/l	Mercury	2 ug/l
Chloride	216 mg/l	Nickel	32 ug/l
Sulfate (as S	52 mg/l	Sodium	543 mg/l
Sulfide	1.5 mg/l	Zinc	88 ug/l
Sulfite	2.3 mg/l	Chromium (total)	10 ug/l
Phenols	0.3 mg/l	Color	2333 s.c.u.
Ammonia (as N)	0.5 mg/l	Specific conductance	2387 micromhos
Nitrate	0.4 mg/l	Turbidity	412 t.u.

COD = Chemical Oxygen Demand
TVS = Total Volatile Solids
TSS = Total Suspended Solids

TDS = Total Dissolved Solids
TOC = Total Organic Carbon

Monthly reports on wastewaters have been submitted to SDHES since 1968. This information includes BOD, chemical oxygen demand (COD), TSS, and color on the clarifier influent and effluent and in addition, sodium, chlorides and conductivity on the clarifier effluent; BOD, COD, pH, sodium, chlorides, color, TSS, tannin on wastewater in the ponds and in the test wells; and dissolved oxygen, BOD, sodium, chlorides, color, TSS, and tannins from the river above and below the mill. The three river stations reported are Harper's Bridge (about two miles above the mill), Marcure Ranch (on the same side and immediately below the mill and within themixing zone) and Huson (Six Mile -

about ten miles below the mill). Bioassays on fish (guppies) are also conducted and reported on wastewaters to be discharged. The MPDES waste discharge permit under which HW will be operating from its date of issue to 1977, will require using Rainbow Trout in their static bioassays to determine the toxicity of their wastes.

D. Energy and Raw Material Consumption

The pulp and paper making process consumes large quantities of energy and raw materials. The HW plant uses an average equivalent of 4,007 kilowatt hours (KWH) of energy per ton of product compared to 702 KWH/ton for lumber and 16,102 KWH/ton of aluminum. The major chemical and energy consumption for HW's Missoula mill are given in Table six. Some explanation and qualification of the table is necessary. The amounts given are based on a specific set of conditions--i.e., ratio of bleached/unbleached pulp, energy supplies, cost factors, raw material supply--and can and probably will vary from month to month and year to year. The data are presented for three sets of circumstances--the present mill, predicted for the mill in the future with no expansion, and for the future mill with expansion. Further discussion regarding the uses of natural resources can be found in Sections III and IV.

Table 6

HOERNER-WALDORF CORPORATION, MISSOULA
MONTHLY WOOD, CHEMICAL, AND ENERGY USAGE

Material	Units	1973	1977 No Expansion	1977 Expanded Mill
Chips	Dry Tons	69,452	69,452	78,700
Sawdust	Dry Tons	2,432	2,432	17,700
Hogged Fuel	Wet Tons	7,840	7,840	19,000
Salt Cake	Tons	1,375	1,375	810
Caustic Soda	Tons	1,044	1,044	1,934
Spent Caustic	Tons	46	46	81
Lime	Tons	275	275	460
Chlorine	Tons	380	380	59
Sodium Chlorate	Tons	27	27	4
Sulfur Dioxide	Tons	15	15	4
Sulfuric Acid	Tons	563	563	703
Alum	Tons	499	499	730
Starch	Tons	608	608	669
Gum	Tons	32	32	97
Bulk Rosin	Tons	4	4	56
Natural Gas	MCF	388,000	388,000*	564,000
Fuel Oil	Gallons	92,000	92,000*	150,000
Purchased Elec. Power	Thous. KWH	12,830	20,140*	34,200

*Subject to changes due to supplies, prices, markets.

E. Wastewater Treatment and Control

From the data presented earlier in this report, it is obvious that substantial in-plant changes can make major improvements in effluent quality from the mill. Regarding in-plant changes, HW (February 26, 1974) said:

> To accomplish this major improvement, additional vacuum drum washing capacity will be added. The existing washing capacity will be increased from 4800 square feet to the equivalent of 12,310 square feet. This results in an increase in the ratio between washer surface area and pulp tonnage washed of 60 percent. In addition, the present spill collection system will be expanded to include facilities to collect losses from the new pulp washers, evaporator carryover, evaporator boilouts, and recovery boiler water washing. These sources represent the major loss points in the existing mill. Also, sufficient evaporator capacity will be included to allow the collected liquor spills to be evaporated and retained in the process.
>
> These changes will allow a significant reduction in the amount of color originating from sources other than the bleach plant. As a result, it is projected that the unbleached portion of our effluent will contain 500 color units, which is representative of the best unbleached Kraft mills in the United States. There have been recent occasions with the bleach plant not operating that the observed color of the total mill effluent achieved a level as low as 800 color units. From this evidence, it does not appear unreasonable to project a level of 500 color units for the unbleached portion of the expanded mill.
>
> In addition to the improvements noted above, the expanded mill will include a revised bleaching sequence with the demonstrated ability to reduce the color of the effluent from the bleach plant by 70 percent. Called the Anti-Pollution Sequence (APS) by its developers, the Hooker Chemical Company, the process involves the replacement of caustic soda in the second bleaching stage with sodium hypochlorite as the bleaching agent. Full scale mill trials of this process were completed in early December, 1973, with the result that the color of the bleach plant effluent was decreased by 70 percent.

HW indicated that the sewered weak black liquor (0.84 mgd) will be eliminated with the new pulp washer system.

The actual loss of sodium to the sewered wastewaters in the unbleached pulp and paper operation indicates the amount of BOD and color which will be present in the wastewater. HW (April 9, 1974) gives the following figures:

SODIUM LOSSES (Pounds of Na/ton)

	Present	Proposed
Pulp washers (remains in pulp and removed in paper mill)	9.7	6.5
Sewered filtrate	8.7	0
Spills, overflows and washups	28.1	14.1
	46.5	20.6

Assuming that BOD will be reduced in proportion to the sodium reduction and using the existing BOD_5 of 56 pounds per ton, a BOD of 25 pounds per ton would be present. This compares favorably with the four mills surveyed by EPA. Using the same assumption, color would be reduced from 78 pounds per ton to 35 pounds per ton. As pointed out by HW this is not a totally valid assumption as the condenser waters are low in color and high in BOD and the condenser flows will increase in almost a direct ratio to pulp production with the concentrations remaining about the same.

The following average discharge volume is computed:

Unbleached pulp: 3,300 gal/ton x 1850 tons = 6.1 mgd

Paper production: 6,000 gal/ton x 1700 tons = 10.2 mgd

Bleached pulp: 30,000 gal/ton x 176 tons = 5.3 mgd

21.6 mgd

This does not include uncontaminated cooling water presently discharged which HW proposes to reuse in part or totally in the expanded plant.

Using the projected values for BOD and color and proposed production capacity of 1850 tons of pulp per day and projected production of the bleach plant of 176 tons per day, the predicted BOD and color values are:

	BOD_5	Color
Pulp and paper	25 #/T x 1850^T = 46,250	35 #/T x 1850^T = 65,000
Bleach	31 #/T x 176^T = 5,500	30% x 1900 #/T x 176^T = 100,000
	51,750 #/day	165,000 #/day

This compares with an average BOD of 71,000 #/day and 395,000 pounds per day color in 1973. It is assumed that the pounds of TSS contributed per day per ton of bleached and unbleached pulp and paper produced will remain essentially the same with the expanded mill as with the present mill.

HW has said that they will reduce color to 500 units in the pulp and paper operation (16.3 mgd). This would amount to 68,000 pounds per day of color. However, to reach this, an extremely efficient spill collection system will be needed along with adequate evaporator capacity to receive the collected spills.

The proposed means of waste disposal following aerobic treatment and settling is a combination of rapid infiltration and disposal through the ground, and storage and direct discharge. During recent years, the direct discharge to the Clark Fork River has been made only when the river exceeded 10,000 cfs in flow. An exception to this was made in 1973 when discharge was allowed when the river was above 7,000 cfs. The major reason for prohibiting discharge during other periods was because of potential toxicity of the wastewater and the opinion of biologists that the discharge would be least critical at this time of the year. The data obtained to date indicates no apparent toxic effect to the fishery has occurred from this practice. With biological treatment in the ponds, the toxicity factor would be greatly reduced and a direct discharge during other periods of the year could be considered. The Department of Fisheries and Wildlife, Oregon State University, used experimental streams to determine the effects of Kraft mill wastewaters on salmonid fish. A summary of this study concluded in part:

> Production of salmonid fish (cutthroat and brown trout, and coho and chinook salmon) was not affected, either favorably or unfavorably, by the presence of either primary treated or biologically stabilized kraft mill effluent at the 0.5 mg/1 BOD level tested. Overall food organism abundance was not much affected by the presence of the effluents,

> although there were changes in the relative abundance of different kinds of food organisms. Adjustments in the feeding habits of the fish apparently prevented the presence of the effluents from having any appreciable influence on the overall growth and production of the salmonid species studies (12).

Pollution sensitive forms were not present in the treated or control streams in the OSU study. Benthic density was not affected on 5 of 8 sampling periods; on the other three, the effect was slight. Microflora counts were not reported. Chlorophyll a decreased in the section receiving untreated wastewaters and increased in the section receiving stabilized effluent.

HW originally projected a requirement of 325 acres of additional ponds, but this acreage should be greatly reduced with usage of their rapid infiltration. Some of the existing ponds are located on the 100-year flood plain but would not come under the Flood Plain Act because they were existing before passage of the act. However, any new ponds would have to meet these requirements.

Any discharge of wastewaters by HW through the combination of effluent disposal practices will be considerably below 0.5 mg/l after mixing with the river. The maximum actural direct discharges would be limited by the allowable color increase (5 units) after deducting the flow needed to dilute color by seepage. Also, it is proposed to limit the direct discharge to the period of October 1 to July 15. Direct discharge would be prohibited during the period July 15 to October 1 when river water temperatures are at their highest. Using U.S.G.S. water year 1937 (2,582 cfs average discharge), which is the lowest water year on record for the U.S.G.S. station below Missoula, a direct discharge averaging 10 cfs could be permitted for the 288-day period. With a daily average waste flow of 21.6 mgd, this would leave 6.0 billion gallons to be disposed of by rapid infiltration during the year. Assuming a 10-year 7-day low flow of 930 cfs, 85 percent color removal by infiltration and flow through the groundwater and rapid infiltration to occur at a uniform rate throughout the year, the maximum increase of color due to seepage would be less than four units. A storage volume of about 3,600 acre-feet would be required with this system.

Using the proposed in-plant changes and waste disposal practices, the existing discharge following biological treatment and discharge concentrations following plant expansion reaching the river are projected below. For comparative purposes, one-third direct discharge and two-thirds seepage are utilized:

Parameter (pounds per day except flow)	Existing Mill	Existing mill with Biological Treatment and APS	Expanded Mill
BOD	18,500	800	2,100
TSS	5,300	1,100	1.700
Total dissolved solids	300,000	350,000	340,000
Color	171,000	80,000	73,000
Sodium	68,000	66,000	51,000
Chlorides	38,000	49,000	55,000
Sulfates	10,000	60,000	60,000
Phenols	17	6	8
Phosphorus as P /	92	43	67
Nitrogen as N /	580	280	440
Flow - mgd	15.8	15.8	21.6

/ includes amounts of nitrogen and phosphorus in all forms including bacteria and algae.

The BOD, TSS, phosphorus and nitrogen values were calculated using effluent concentration values presented by HW consultants. Flow values of 24.8 mgd were utilized in these calculations which should make these projected values conservative when utilizing an flow of 21.6 mgd. The new flow of 21.6 mgd was presented by HW after the original calculations for the aeration basin were made. A flow of 21.6 mgd was utilized in calculation of quantities of other constituents.

The calculations are based on the assumption that after installation of the biological treatment system, the soluble phosphorus (P) and nitrogen (N) concentrations will be 0.3 mg/l and 2 mg/l, respectively. Also, the TSS in the direct discharge contributes P and N in the ratios of 100 pounds BOD to 5 pounds of N to 1 pound P and that 1 mg/l TSS contributes 0.3 mg/l BOD. It is further assumed that there will be no reduction of soluble N and P due to seepage.

Sodium levels will decrease with the expanded mill because of reduction in sodium losses. Chlorides will increase with substitution of the APS system in bleaching. Sulfates will increase with installation of aeration basins as anaerobic decomposition of sulfates which presently occurs should be considerably inhibited. A reduction of sulfates per ton will also occur with reduction of sodium losses.

With regard to alternate treatment systems, HW says: (February 26, 1974)

> With the installation of secondary treatment, the disposal of the effluent from the present or expanded mill will meet all water quality criteria, with the possible exception of color during low-flow years. Rapid infiltration, combined with the new APS bleaching system, should allow the expanded mill to also meet the color standard.
>
> Other systems of color removal have been operative for short periods of time at other Kraft mills in the United States. The treatment system commonly used involves lime addition to the highly colored portion of the effluent.
>
> The advantage of a color removal system by lime addition, presently in use by a few companies, is that color reduction may be sufficient for year-round discharge of water, with the possible exception of extremely low stream flows.
>
> Disadvantages of this system applied to the HW situation are as follows:
>
> 1. It is costly. An EPA report on Kraft pulp mills indicate that operating costs on a plant producing 197,000 tons per year of unbleached pulp increase $1.47/ton of pulp produced for yearly operation, while total costs equal 1.95/ton of pulp. THis information does not directly apply to the HW plant at Missoula, because bleached pulp is also produced, and this production creates much more color in the effluent than unbleached pulp requiring perhaps greater costs. However, some recovery of lime from this process has been accomplished at other mills, which lowers the final costs.
>
> 2. The state of this technology is in its infancy and its feasibility has not been thoroughly established. Further investigation by HW beyond the data available from the EPA has revealed several problems with the lime treatment. The Interstate Paper Company installation in Riceboro, Georgia, does not recover the lime used for color removal. The massive lime process which was trialed at the International Paper Company mill, Springhill, Louisiana created operating problems in the recausticizing department when the lime was reintroduced back into the process. According to the report, the

lime system at the Continental Can mill in Hodge, Louisiana is the best full-scale color removal system operating today. However, there are reports of operating problems in recovering the lime.

3. Increased uses of limited resources will be required. In addition to lime, electrical energy consumption will be increased. Again, at the Interstate Paper Company, there was an additional expenditure of $14,000 annually for electricity to operate the color removal system. This must be considered in light of the present energy shortage.

Other color removal systems, such as ion exchange, carbon adsorbtion, and ozone treatment, are effective in the laboratory or pilot plant basis, but no full scale operations have been established. Several of these systems appear promising, and may provide systems of color removal superior to lime treatment.

In short, the development of color removal technology is proceeding rapidly. Besides effluent treatment systems, in-plant procedures, such as the APS bleaching sequence, are being developed, to reduce the generation of colored effluents. Rapid infiltration, combined with in-plant improvements, should allow HW to meet the color standard without the large commitment of resources that would be required to install and operate presently available color removal system. However, should the present approach of rapid infiltration, APS bleaching and other in-plant improvements indicate that this sytem will not allow the color standard to be met, further steps will be taken, up to and including color removal from selected effluent streams, so that the expanded mill will meet the color standard.

The following estimates are provided for lime treatment and carbon adsorption for the total waste streams:

	Lime Treatment	Carbon Treatment	Rapid Infiltration
Capital Costs (based on January 1, 1974, costs)	$4,500,000	$8,000,000	$1,000,000
Operating and maintenance costs/month	$30,000	$150,000	$5,000
Gas-Btu/month	43,000,000,000	18,000,000,000	0
Power-KWH/month	900,000	435,000	0

The costs for lime treatment are based on burning of the lime sludge in a lime kiln to recovery lime. Lime treatment in conjunction with the biological treatment should enable HW to meet BPCT limits and color standards without utilization of the seepage system. Carbon adsorption would provide a better overall treatment than lime treatment and would provide a treatment comparable to the proposed rapid infiltration system. The high operating cost of carbon treatment is due to replacement of a portion of carbon which is lost in its regeneration by burning the organics from it. Lower cost sources of activated carbon are presently being sought and experimental work is underway. If activated carbon costs can be reduced, this means of treatment would look much more favorable. If large quantities of wastewater were to be treated by carbon adsorption, the use of lime treatment ahead of this sytem would probably reduce the total operating costs of the system as lime would remove a portion of the load from the carbon system. Adoption of groundwater standards by the state, which are expected in a one to two-year period may also make chemical and/or physical treatment a necessity.

If rapid infiltration tests not completely successful in removing color to meet standards, or if it appears that domestic wells adjacent to HW property will by polluted with the increased water discharge, an alternate means of treatment will be required. However, if this were the case, it is expected that only the more contaminated wastewater streams would be treated. Further, it would be expected that aeration would be utilized for the total wastewater stream, chemical or physical treatment for a portion, rapid infiltration of a portion, and storage with discharge during high water of a portion. The final decision on whether chemical or physical treatment will be required will be made after more groundwater information becomes available through experimental work presently being performed. It is expected that this decision will be made during the summer of 1975.

III. EXISTING ENVIRONMENT AND POSSIBLE EFFECTS OF EXPANSION

A. Air Quality

PHYSICAL SETTING

HW lies west of the Continental Divide within the Missoula Valley. The valley floor runs roughly northwest to southeast with elevations ranging around 3000-3200 feet above sea level. Wooded mountains surround the valley. Most of the 58,300 residents of Missoula County live within the Missoula Valley itself. Missoula's population was approximately 44,000 at the 1970 census.

CLIMATOLOGY (13)

Missoula is situated in the Montana Rocky Mountains in the extreme north portion of the Bitterroot Valley, and about five miles east of the confluence of the Bitterroot and Clark Fork Rivers. The Clark Fork Valley extends about 20 miles west-northwestward from Missoula. The Bitterroot Valley runs southward about 70 miles from Missoula.

The Continental Divide is 60 to 80 miles east of Missoula, and the Bitterroot Range is only about 20 miles away to the southwest. These two mountain ranges have a marked effect on the climate of Missoula.

The prevailing flow of air aloft over western Montana is from the west and southwest during spring and summer, and from the west and northwest during the winter. This air must pass over the Bitterroot Range, and it loses much of its moisture on the western slopes of these mountains. As a result, Missoula received an annual average of between 12 and 15 inches of precipitation. This small amount of precipitation leads to a semiarid climate. The heaviest precipitation is received during May and June, with average rainfall of about two inches in each of these months.

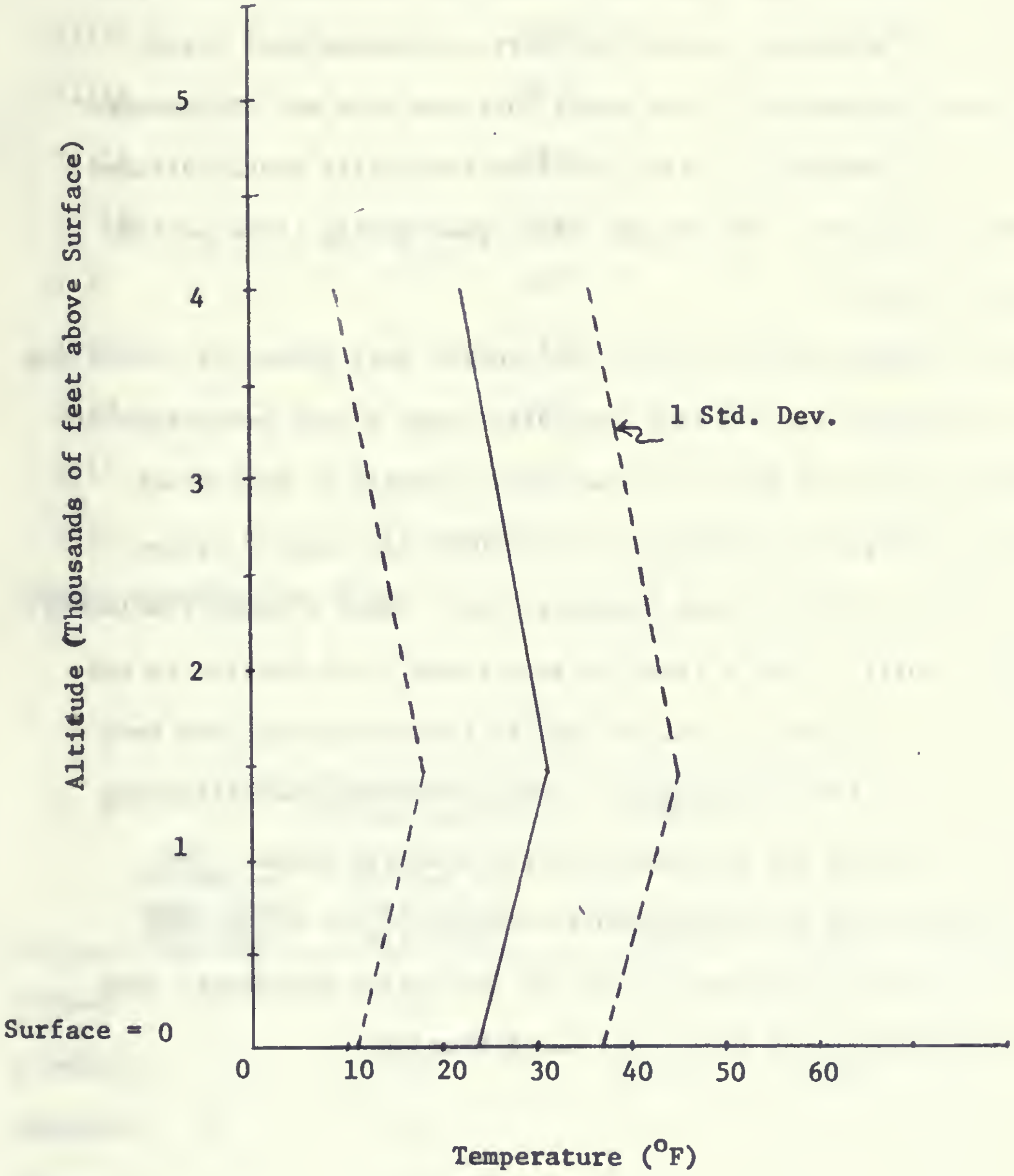
Generally the spring months are cool and a little damp, with almost daily shower activity during May and June. The last spring freeze normally occurs about the middle of May, and there are about 137 growing days each year between the last spring freeze and the first fall freeze. The summer months are dry with moderate temperatures and cool nights. Seldom does the temperature reach 100°. Minimum temperature during July and August average near 50°.

In the winter, the Continental Divide shields the Missoula area from much of the severely cold air which moves down the continent from arctic regions. Because of this shielding effect, many of the cold waves which sweep down over eastern Montana miss the Missoula area entirely. Under certain conditions, however, the cold arctic air does break over the Continental Divide, and moves with force into the Bitterroot and Clark Fork Valleys. When this happens, Missoula experiences severe blizzard conditions. The cold air is "funnelled" to the city through the Hellgate Canyon of the Clark Fork River. After the valleys of western Montana are filled with the cold air, prolonged cold spells may occur. January is the coldest month, although periods of subzero weather occur occasionally in December and February. There are rare brief periods of subzero weather in November and March.

Data collected from October 1, 1971 through January 31, 1972 by SDHES showed that in the Missoula Valley, the average inversion height was 1500 feet above the valley floor (Figure 4). For areas such as the Missoula Valley where the area is surrounded by high mountains, the data that should be used is the mixing height rather than inversion height. Using data collected at the Johnson-Bell Field for mixing heights shows an

Figure 4

Average Missoula Inversion Temperature Profile
Missoula Field
October 1, 1971 through January 31, 1972



average height of 939 feet (Table 7). Values are as low as 350 feet for the period of December 5, 1973 through February 12, 1974. Wind directions during these periods are characterized by light easterly winds at night and in the mornings and by light west-northwesterly winds in the afternoon Table 8 shows the average wind speed and percent of time wind blows from the WNW and ESE for the months October-February at Johnson-Bell Field. Table 8 also shows the percent of the hours that are calm and the average temperature. The percentages of wind direction are fairly evenly divided between the two categories. The average wind speed during these periods is about 6 mph or 3 m/sec.

Wind data for Johnson-Bell Field for the entire year shows the prevailing wind as NW to W (Figure 5). The wind rose also shows a high percentage of calms. Comparing this wind data with the data collected at Rock Creek South Wind Station (Figure 6) operated by the SDHES Air Quality Bureau (AQB) for the period of May through November, 1973, shows a close similarity. There is a slight shift to the W from the Rock Creek South Station to the Johnson-Bell Field. This shift could be due to the nearness to the Rock Creek Canyon to the north of the station. The shift would be reflecting local up canyon day winds and down canyon night drainage winds. The wind data still shows the wind direction prevailing is out of the WNW but a strong component is also out of the ESE indicating pollutants from HW should be traveling to the Rock Creek South Station.

Table 7

JOHNSON-BELL FIELD MIXING HEIGHT DATA

Date (73-74)	Time (MDT)	Mixing Heights* (ft)
12/5	0830	1200
12/10	0830	700
12/14	0830	850
12/18	0830	1750
12/19	0830	1200
1/2	0920	500
1/10	0930	1300
1/23	0830	350
2/11	--	640
2/12	--	900

*Height above valley floor

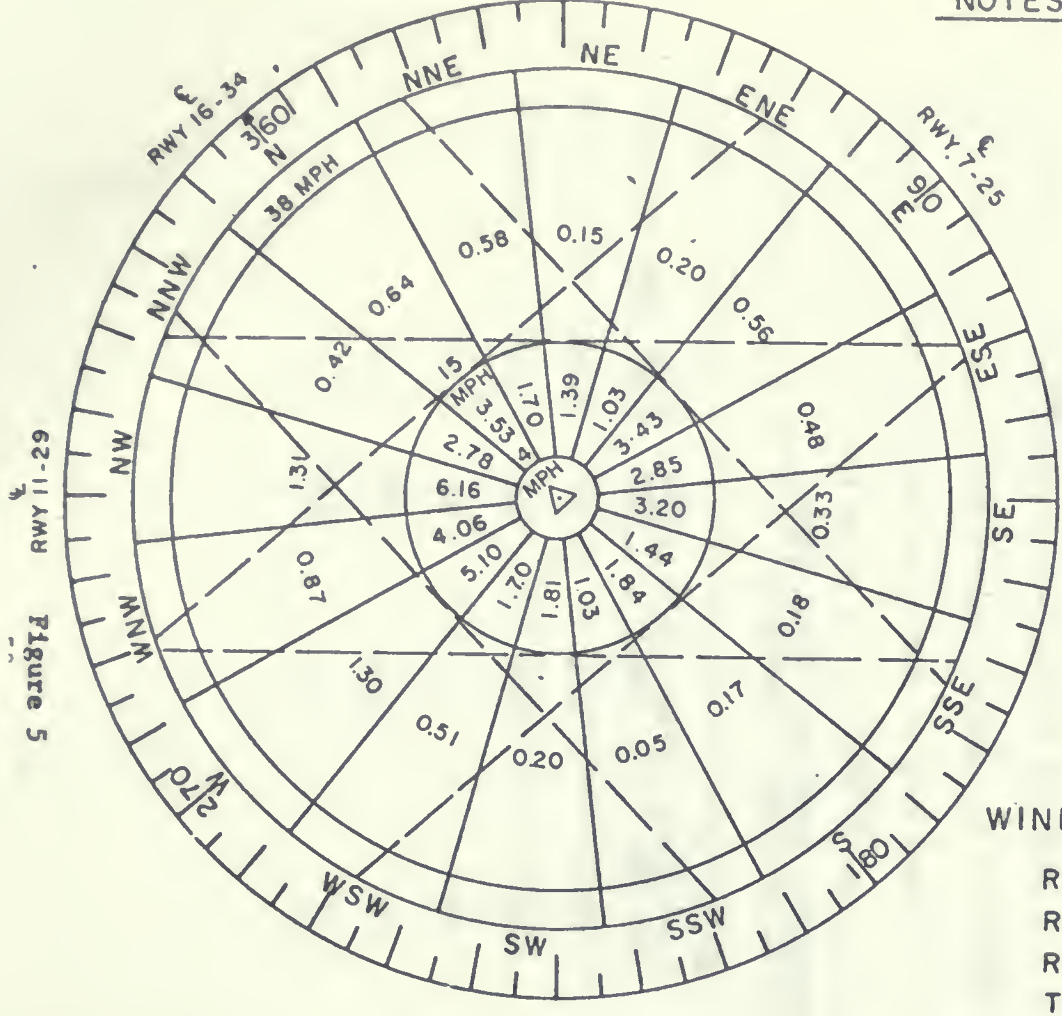
Table 8

WIND DIRECTION, SPEED AND CORRES. TEMP.
Johnson-Bell Field (1949-65)

	Percent of Total Hours Dir. WNW	Percent of Total Hours Dir. ESE	Aver. Speed (mph)	Calm (%)	Aver. Temp. (^{o}F)
October	26	18	6.6	15	44.6
November	25	21	6.3	16	31.5
December	23	22	5.7	20	25.2
January	21	24	5.1	19	20.1
February	26	21	6.3	13	27.4

NOTES:

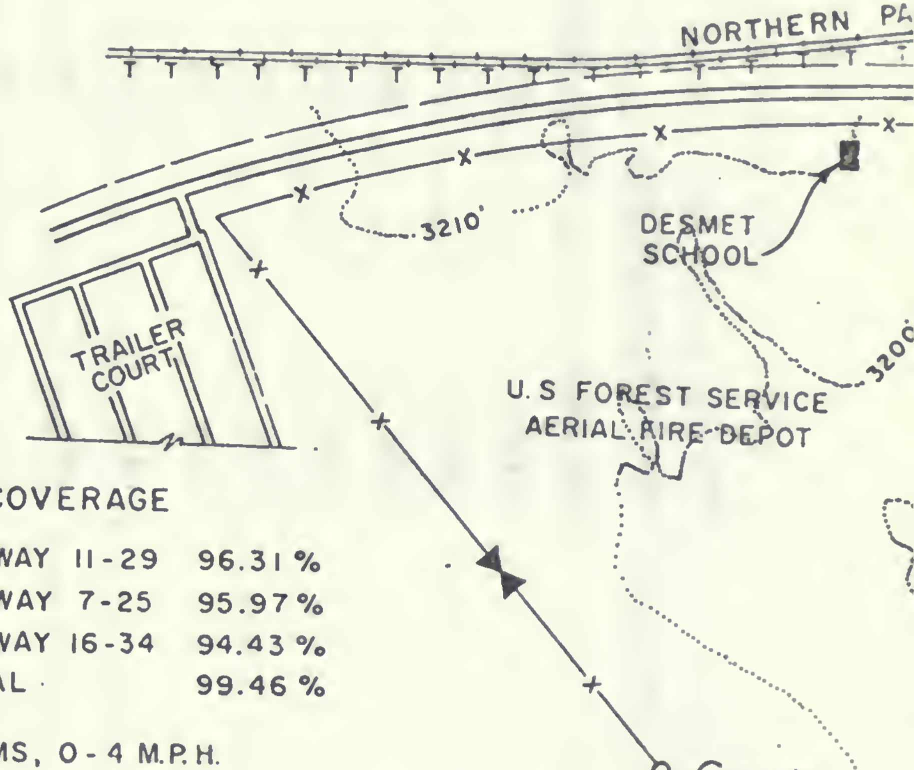
1. WIND INFORMATION TAKEN FROM PREVIOUS AIRPORT LAYOUT PLAN DATED AUGUST, 1959. AND REVISED JAN., 196
2. COMPILED FROM RECORDS OF THE U.S. WEATHER BUREAU AT MISSOULA COUNTY AIRPORT OVER A PERIOD OF 5 YEARS FROM JAN., 1951 TO DEC., 1955.



WIND COVERAGE

RUNWAY 11-29	96.31 %
RUNWAY 7-25	95.97 %
RUNWAY 16-34	94.43 %
TOTAL	99.46 %

WIND ROSE △ = 49.0 % CALMS, 0-4 M.P.H.



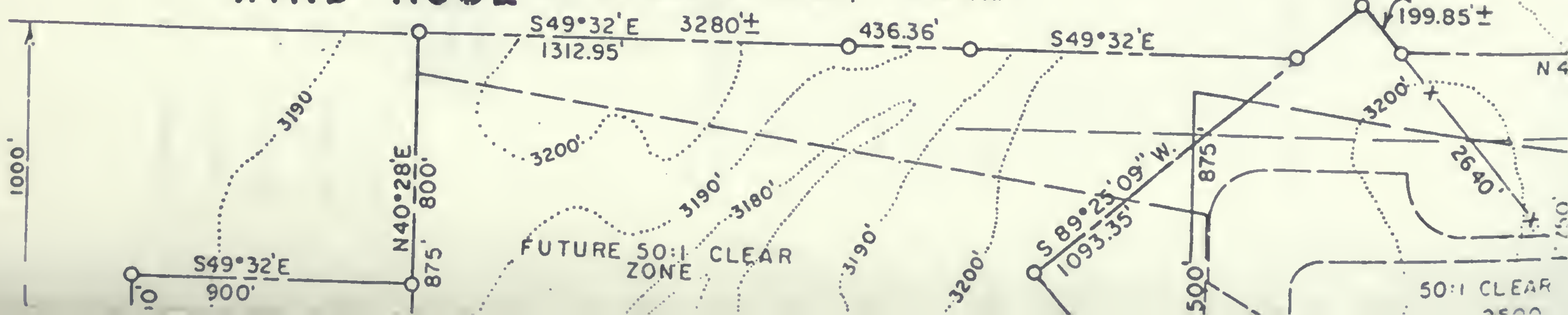
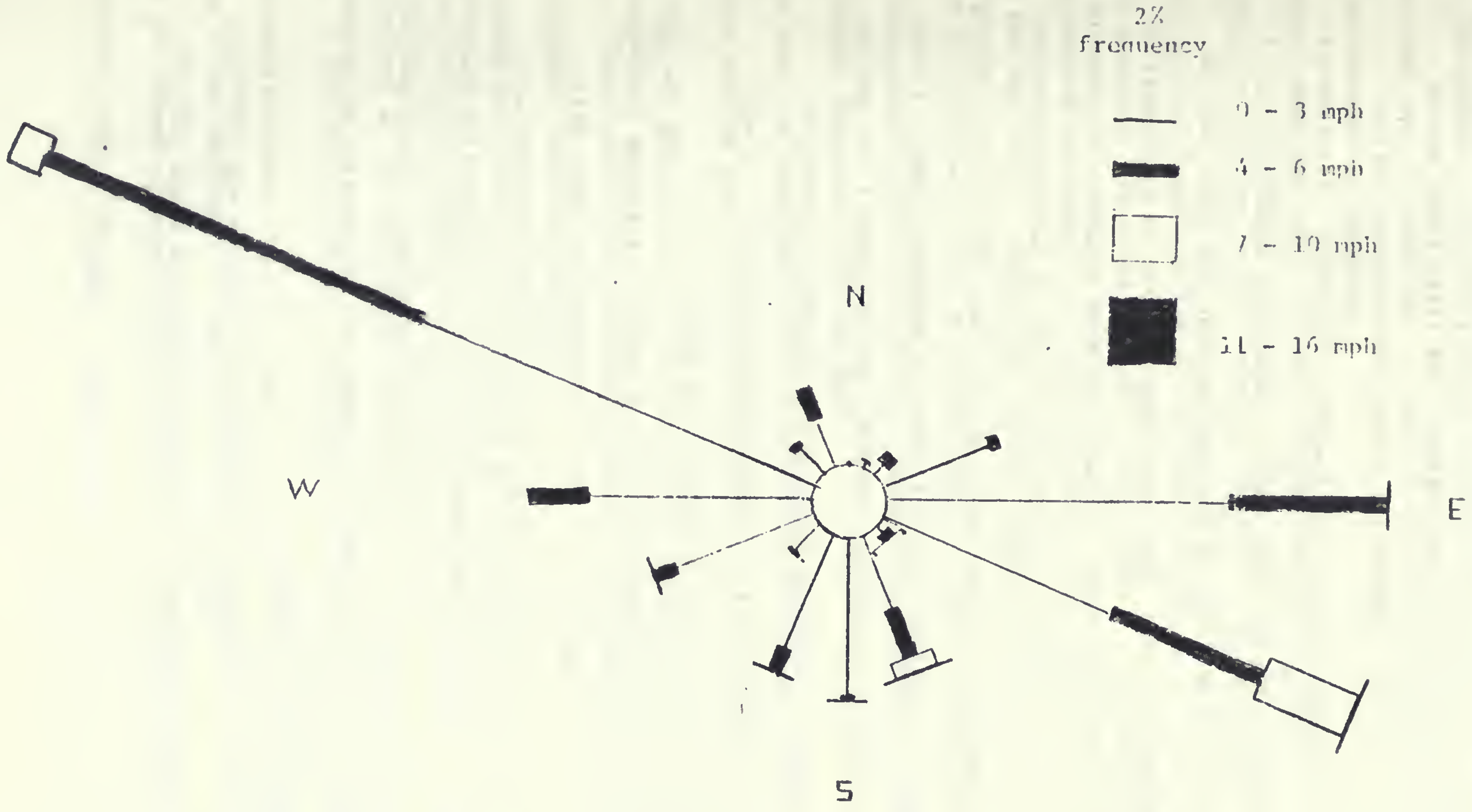


Figure 5

ROCK CREEK SOUTH WIND ROSE



Wind blows toward the center

These data were collected with an MRI 1072-1 located on a mountain ridge two miles west-northwest of the H-W mill in the Missoula Valley. Results were taken from data collected during the period of May through November, 1973. Data were extracted from charts for one hour intervals.

Figure 6

AIR QUALITY

When HW publically announced on August 28, 1973 that it was proposing a plant expansion, SDHES set out to determine what would be necessary for an impact study to assess the proposed expansion. The first thing needed was a characterization of the ambient air within the Missoula Valley.

The Missoula City-County Health Department's continuing collection of suspended particulates in the air was useful. Since the manufacturing of pulp and paper causes the emission of hydrogen sulfide and other odorous organic sulfur compounds, it was clear that these too had to be identified and quantified in the Missoula area. It has long been apparent to Missoula residents that there is an odor problem there, caused by odorous emissions from the pulp and paper mill. These odors are at times described as strong, permeating, pungent and putrid. Odor pollution is becoming a major factor in the total air pollution problem in the U.S. Because odor is so easily noticed, complaints about obnoxious odors are frequently received by air pollution control authorities. In the Missoula Valley it is well established that HW is the source of most of the odor.

The AQB lacked sufficient funds to set up a monitoring system sophisticated enough to characterize the ambient air around the pulp and paper mill. HW was advised it would be responsible for gathering the necessary air quality information. The bureau designed the network and specified essentially what equipment should be used. HW, having little experience in air pollution monitoring, contracted with Environmental Science and Engineering of Gainesville, Florida, to provide SDHES with data.

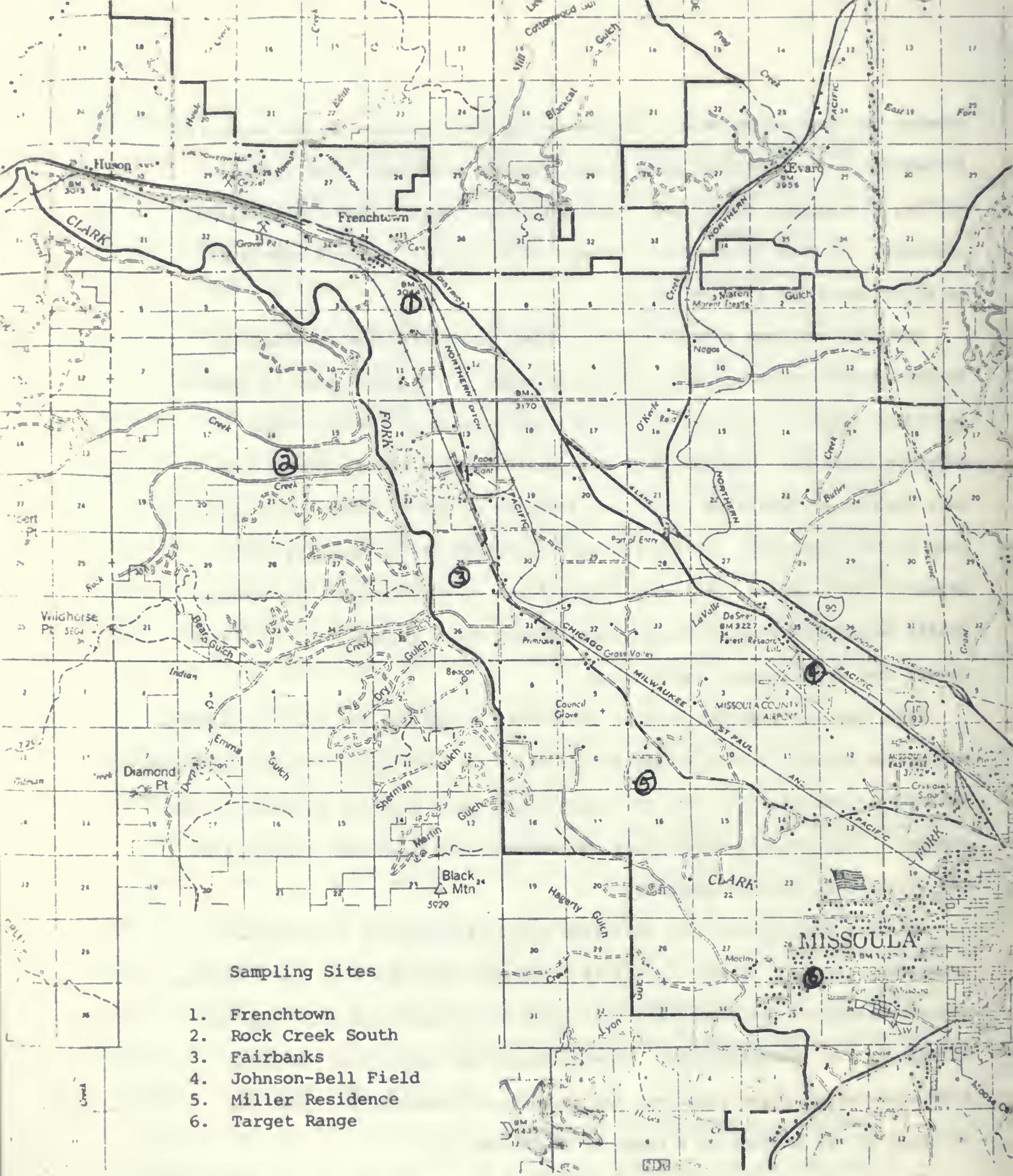
To assure that the information furnished by the company was credible, a quality control program was set up providing guidelines which both the company and contractor were to follow during the operation of the samplers. Parameters to be monitored were sulfur dioxide, sulfides, total reduced sulfur, mercaptans, disulfides, total suspended particulates, particulate sulfates, and wind information. A copy of the quality control submittal to HW is contained in Appendix C.

Numerous meetings were held with company and contractor officials to define details relating to this sampling network. The map shown in Figure 7 indicates sampler locations for the initial portion of the year-long sampling contract. Stations were set out to monitor the air where there were population densities, with the exception of the station on the hill west of the pulp mill. During the initial phases of the sampling which began in mid-December, 1973, Mr. Roland Samel of the Missoula City-County Health Department visited the stations almost daily in behalf of the City-County Health Department and the AQB.

Data from the sampling done by University of Montana for hydrogen sulfide and sulfur dioxide gave a longer term look at the air quality within the Missoula Valley than was possible with the eight months data supplied to SDHES by the company. Considerable particulate and sulfate data have been collected by the City-County Health Department.

Although wet chemical air pollution monitoring methods are extremely sensitive, they are subject to errors which are unavoidable at low pollutant concentrations as the absorption efficiency is variable and often unpredictable at low concentrations. Interferences and sample loss resulting from aqueous/gas phase reactions and photo/heat decomposition limit the accuracy of wet methods to a range of 10-20 ppb. (14)

New gas chromatography column technology and the flame photometric detector have enabled equipment manufacturers to develop highly specific



Sampling Sites

1. Frenchtown
2. Rock Creek South
3. Fairbanks
4. Johnson-Bell Field
5. Miller Residence
6. Target Range

Figure 7 Map showing relative location of the plant and the Air Quality Bureau sampling stations.

sulfur gas analyzers which routinely measure sulfur gas concentrations below 10 ppb. Since the reported odor threshold of a number of reduced sulfur compounds is below 5 ppb and since HW emits reduced sulfur compounds, it was essential that the most accurate and sensitive method be employed in this study.

Odor thresholds have been established approximately as follows for some sulfur compounds believed to be present in the ambient air in Missoula (15).

Hydrogen sulfide	3 - 5 ppb
Methyl Mercaptan	0.5 - 0.8
Isopropyl Mercaptan	0.5
Butyl Mercaptan	0.5
Dimethyl Disulfide	20
Sulfur Dioxide	300

Since a separation between reduced and oxidized sulfur compounds is required, two gas chromatographic (G.C.) sulfur analyzers were purchased by HW for this study. The Tracor Model 270-HA was selected based on unofficial preliminary evaluations by the EPA and on the successful experience Environmental Science and Engineering personnel have had with Tracor analyzers. The stock 270-HA provides an analysis of ambient sulfur concentrations once every 225 seconds. The Target Range analyzer was programmed to determine sulfur dioxide, hydrogen sulfide, and total sulfur with a silica gel column on automatic mode. A second 270-HA was modified to do a complete analysis for total sulfur, sulfur dioxide, hydrogen sulfide, methyl and ethyl mercaptan, dimethyl and dimethyl disulfide and carbonyl sulfide within a 15 minute cycle. This analyzer, equipped at the factory with a polyphenyl ether coated teflon column, was operated at the Frenchtown site. Dual pen recorders provide simultaneous output for the 0-100 ppb range and for the 0-1 ppm range to insure that the greatest sensitivity and range is covered.

Table 9 and 10 contain data collected by the gas chromatographs at the Target Range and Frenchtown locations for an eight month period. Dates and running times are given for violations of Montana's hydrogen sulfide regulations.

The regulations are found in Table 11.

Table 9

TARGET RANGE GAS CHROMATOGRAPH

	Period			H_2S Concentration PPB
Date	Begin Time	End Time	No. Viol. In Period	Max. 30 min. Average
12/10	1804	2004	4	40.7
12/11	0556	0556	32	89.6
12/13	0919	949	1	34.3
12/15	1604	0634	29	79.2
12/16	0953	1523	13	46.1
12/16	0841	0249	16	83.7
12/17	0704	0856	4	91.6
12/17	1649	1819	3	47.7
12/17	2334	0034	2	35.0
12/20	2234	0404	11	99.8
12/21	1338	1438	2	50.9
12/21	1653	1753	2	34.0
12/21	1926	2323	66	59.0
12/22	0011	0241	5	57.4
12/22	0404	0604	4	56.9
12/22	0734	1304	11	47.6
12/28	2011	2111	2	34.2
1/13	0741	1111	7	42.9
1/13	1308	1338	1	44.8
2/12	0953	1134	3	36.0
3/12	0741	0811	1	32.8
3/15.	0823	0853	1	30.2
3/17	0349	0419	1	33.9
3/21	0356	0426	1	36.0

Table 9 (cont.)

TARGET RANGE GAS CHROMATOGRAPH

Date	Period Begin Time	End Time	No. Viol. In Period	H_2S Concentration PPB Max. 30 min. Average
	0441	0511	1	36.9
	0511	0541	1	33.9
3/23	0638	0708	1	30.7
3/24	0749	0819	1	35.1
3/27	0908	0938	1	41.7
4/1	0926	1026	2	41.0
4/14	0834	0904	1	32.5
4/15	0823	0853	1	34.4
4/16	1141	1211	1	34.9
4/18	0949	1019	1	33.9
	2126	2156	1	32.2
4/19	0311	0341	1	33.3
4/21	0708	0919	4	51.9
4/22	0826	0926	2	59.0
4/23	2111	2141	1	35.0
4/24	0353	0538	3	60.5
	0656	0726	1	39.1
	2311	2341	1	48.0
4/25	0304	0408	2	37.4
	0538	0704	2	46.1
4/26	0726	0756	1	42.1
4/28.	0326	0356	1	40.7
5/6	0904	1104	4	147.0
5/7	0911	1141	5	125.7

Table 9 (Cont.)

TARGET RANGE GAS CHROMATOGRAPH

Date	Period Begin Time	Period End Time	No. Viol. In Period	H_2S Concentration PPB Max. 30 min. Average
	1853	1923	1	34.0
5/9	0756	0956	4	62.0
5/12	0249	0626	6	91.6
	0741	1011	5	62.4
5/14	0923	0953	1	30.9
5/16	0741	0811	1	31.2
Information in the following Section is estimated from check sheets made from the charts.				
5/17	0600	0900	6	60.
5/23	0800	0900	2	60.
5/27	1600	1900	3	80.
	1900	2100	4	50.
6/1	0830	1000	3	55.
6/16	0530	0700	3	55.
6/21	0815	0915	2	44.
6/22	0730	0830	2	54.
6/24	1000	1030	1	34.
7/15	0015	0045	1	34.
	1115	1145	1	49.
7/17	2100	2130	1	37.
7/22	0915	1015	2	53.
7/23	0100	0130	1	48.
	0300	0400	2	36.
7/29	0845	0945	2	41.
7/31	0845	0915	1	36.

Table 9 (Cont.)

TARGET RANGE GAS CHROMATOGRAPH

Date	Period Begin Time	End Time	No. Viol. In Period	H_2S Concentration PPB Max. 30 min. Average
8/1	0600	0630	1	69.
	0800	0900	2	56.
8/6	0845	0915	1	55.
8/14	0815	0915	2	33.
8/20	0615	0645	1	50.
8/22	0800	0830	1	44.
	0930	1000	1	51.
8/24	0930	1000	1	37.
9/3	0830	0930	2	64.
9/8	0745	0945	4	92.
9/13	0930	1000	1	44.
9/16	0900	1030	3	63.
9/28	0900	1100	4	89.
10/2	0900	1000	2	74.
			Total Number of Violations - 343	High Reading - 147.0

Table 10

FRENCHTOWN GAS CHROMATOGRAPH

	Period			H_2S Concentration PPB
Date	Begin Time	End Time	No. Viol. In Period	Max. 30 min. Average
12/10	1956	2056	2	40.8
12/10	2123	2253	3	50.2
12/10-11	2323	1823	38	150.2
12/11	2008	2134	3	130.5
12/11	2241	2311	1	66.8
12/12	0053	0149	2	123.7
12/12	0456	0623	3	44.0
12/12	1238	1619	7	116.2
12/12	2023	2123	2	168.8
12/12	2153	2349	4	124.1
12/13	0234	0334	2	37.7
12/13	0619	0649	1	91.8
12/13	1208	1334	3	116.8
12/13	1453	1523	1	37.4
12/13	1953	2053	2	33.3
12/13	2308	2338	1	58.3
12/14	0034	0104	1	49.5
12/14	1149	1219	1	38.5
12/14	2004	2026	1	58.6
12/14-15	2123	0223	10	123.3
12/15	1719	1749	1	38.1
12/15	2008	2208	4	40.1
12/15	2308	2338	1	37.9
12/16	0219	0249	1	31.4
12/16	0508	1838	18	63.2
12/18	0404	0434	1	100.7
12/18	1356	1556	4	50.5
12/19	0219	0241	1	127.3
12/20	0649	0919	5	76.3
12/20	1708	1738	1	35.8
12/20	1834	2104	5	41.8
12/21	0423	0534	2	38.9
12/21	0749	1449	14	114.4
12/21-22	1534	0108	19	124.4
12/22	0149	1549	28	134.2
12/22	1919	2319	8	138.7
12/23	0119	0349	5	120.0
12/24	1319	1419	2	67.0
12/26	1319	1549	5	61.6
12/26	1623	1653	1	41.4
12/28	0841	0911	1	36.0
12/29	0419	0519	2	47.4
12/29	0749	0819	1	44.8
12/29	1308	1408	2	46.0
12/29	1556	1734	3	46.4
12/29	1919	1949	1	30.4
12/31	1904	2134	5	48.6

Table 10 (Cont.)

FRENCHTOWN GAS CHROMATOGRAPH

	Period			H_2S Concentration PPB
Date	Begin Time	End Time	No. Viol. In Period	Max. 30 min. Average
1/1	0034	0134	2	41.3
1/1	0149	0449	6	57.2
1/1	0538	0838	6	78.7
1/1	0941	1219	5	62.5
1/1	2123	2256	3	42.4
1/4	1938	2008	1	43.5
1/13	1519	1549	1	37.5
1/14	2049	2119	1	48.5
1/14	2226	2256	1	33.7
1/15	0256	0326	1	73.1
1/15	1749	1819	1	46.0
1/16	1211	1411	4	97.4
1/16	1749	1949	4	93.6
1/17	2041	2111	1	34.7
1/19	0053	0241	3	62.5
2/7	0319	0549	5	71.1
2/10	0053	0323	5	81.0
2/10	0353	1153	16	58.9
2/10	1223	1253	1	31.7
2/10	1718	1818	2	33.0
2/10	2314	2344	1	96.8
2/10-11	2344	0221	6	129.7
2/11	0834	1104	5	55.0
2/11	1134	1334	4	54.3
2/13	0426	0456	1	30.6
2/14	0338	0408	1	30.8
2/14	1153	1223	1	39.9
2/25	1453	1523	2	80.0
2/25	2134	2204	1	60.5
2/26	0319	0419	2	106.1
2/26	1256	1356	2	39.1
2/28	1011	1041	1	69.9
2/28	1056	1126	1	38.3
3/10	1923	1953	1	37.4
3/10	2038	2108	1	36.2
3/11	2141	2341	4	62.1
3/11-12	2341	0111	3	52.9
3/12	1604	1634	1	36.1
3/14	0204	0304	2	35.1
3/14	2204	2334	3	44.4
4/29	0736	0806	1	40.0
4/30	0110	0140	1	32.1
5/1	0316	0346	1	46.7
5/1	0352	0452	2	38.9
5/1	0458	0528	1	40.0
5/7	2114	2214	2	48.5
5/7	2220	2320	2	147.1
5/8	0356	0456	2	41.8
5/8	0502	0602	2	85.7

Table 10 (Cont.)

FRENCHTOWN GAS CHROMATOGRAPH

Date	Period Begin Time	End Time	No. Viol. In Period	H_2S Concentration PPB Max. 30 min. Average
5/8	0608	0708	2	65.2
5/8	0714	0814	2	46.9
5/10	0822	0852	1	38.7
5/10	0858	0958	2	53.1
5/10	1004	1034	1	34.5

Following data are estimated from material taken from charts as check.

Date	Period Begin Time	End Time	No. Viol. In Period	H_2S Concentration PPB Max. 30 min. Average
5/26	2400	0100	2	52.0
5/28	0900	1000	2	45.0
5/30	0800	0900	2	46.0
6/3	0100	0300	4	100.0
6/14	--	--	3	42.0
6/18	--	--	5	110.0
6/27	--	--	4	90.0
7/15	0930	1000	1	39.0
8/1	0015	0045	1	39.0
8/4	2200	2230	1	53.0
8/6	0330	0700	6	75.0
8/11	0100	0200	2	96.5
8/11-12	2100	0100	10	107.5
8/15	2100	2200	2	72.5
8/21	2200	2400	4	65.0
8/26	2400	0030	1	31.0
8/27	0300	0500	4	64.5
8/27	2000	2300	5	140.0
8/28	2400	0100	2	86.0
8/28	2200	2300	2	97.5
8/29	2000	2200	3	78.5
8/30	2400	2430	1	73.8
8/30	0100	0400	6	58.8
8/30	2300	2400	2	103.5
9/2	2000	2100	2	105.0
9/3	1900	2100	4	89.0
9/6	0030	0300	5	84.0
9/8	0700	1000	6	125.0
9/8	1100	1130	1	35.0
9/14-15	2030	0100	9	74.0
9/16	0100	0130	1	39.0
9/16	2000	2300	6	88.5
9/17	2000	2100	2	74.0
9/19	0400	0500	2	54.5
9/19	2300	2400	2	79.5
9/20	2100	2400	6	112.5
9/21	2030	2230	4	89.0
9/22	2000	2200	4	113.5

Table 10 (Cont.)

FRENCHTOWN GAS CHROMATOGRAPH

Date	Period Begin Time	End Time	No. Viol. In Period	H_2S Concentration PPB Max. 30 min. Average
9/22	2230	2330	2	32.0
9/23	1000	1030	1	50.0
9/24	1900	2000	2	51.5
9/25	1030	1100	1	36.0
9/28	2200	2400	4	114.5
			Total Violations 12/73 to 10/74 - 503	High - 168.8

Table 11

APPLICABLE AMBIENT AIR STANDARDS (a) (b)

Contaminant	Standard
Sulfur Dioxide	20 ppb (state), annual arithmetic mean 100 ppb (state), 24-hr average not to be exceeded over one percent of the days in any 3 month period. 140 ppb (federal), 24-hr average not to be exceeded more than once a year. 250 ppb (state), 1-hr. average to be exceeded no more than one time in 4 consecutive days. 500 ppb (federal), 3-hr average not to be exceeded more than once a year.
Hydrogen Sulfide	30 ppb (state), 30-minute average to be exceeded no more than two times in 5 consecutive days. 50 ppb (state), 30-minute average to be exceeded no more than two times annually.
Total Suspended Particulate Matter	60 ug/m^3 (federal secondary) annual geometric mean. 75 ug/m^3 (federal primary) annual geometric mean. 150 ug/m^3 (federal secondary) maximum 24-hr concentration not to be exceeded more than once a year. 200 ug/m^3 (state) to be exceeded no more than three times a year. 260 ug/m^3 (federal primary) maximum 24-hr concentration not to be exceeded more than once a year.
Suspended Sulfate	4 ug/m^3 (state) annual arithmetic average. 12 ug/m^3 (state) to be exceeded no more than three times a year.
Sulfuric Acid Mist	4 micrograms per cubic meter of air, maximum allowable annual average. 12 micrograms per cubic meter of air, not to be exceeded over 1 percent of the time. 30 micrograms per cubic meter of air, hourly average, not to be exceeded over 1 percent of the time.

(a) Federal REgister, Volume 36, No. 84, Part II, April 30, 1971.
(b) Montana Administrative Code 16-2.14(1)-S14040 Ambient Air Quality Standards.

HYDROGEN SULFIDE

Considering first the Target Range station which is 9.67 miles southeast of the pulp and paper mill, several readings were as much as three times the 30-minute allowable level for hydrogen sulfide (H_2S). If 3-5 ppm H_2S represents the odor threshold, then 10 miles from the plant there were ambient levels 20 to 30 times the odor threshold. People in the Target Range area were for 16 hours on December 11, 1973 subjected to H2S concentrations considerably higher than Montana's regulation allows. For 5.2% of the first two month monitoring period, hydrogen sulfide levels in the area were above 30 ppb. For the period Feb. 2--May 16, 1974 the number of 30-minute average concentrations which fell into various concentration ranges are listed in Tables 12 and 13 . An emission roll-back to meet state air quality standards would require a 70% improvement from the December 20 H_2S concentration. At the Target Range station for the first two month period approximately 69% of the data was recovered for use in this statement. In order to establish validity EPA suggests that 75% of the data collected from continuous monitoring equipment should be recovered. Startup problems were numerous and many operational difficulties arose, but these are documented to the extent that the Air Quality Bureau accepted the data as valid.

As indicated in Appendix C, the bureau checked all readings before they were analyzed by HW's contractor to insure correct interpretation of data. Some difficulty arose with regard to calibration curves and their relationship to the total data reduction but the company corrected this. On April 10-11 AQB personnel performed a dynamic calibration on the Target Range gas chromatograph and it agreed with the company's calibration.

Doctor Ron Erickson's university group obtained on December 17, 1973, a 30-minute wet chemistry reading of 112 ppb H_2S at 4801 Sundown Road. This is roughly in the Target Range area.

Table 12

30-Minute Hydrogen Sulfide Observations, Hoerner-Waldorf, Target Range, February 2, 1974 - May 16, 1974.

Range ppb	Number of Observations
0-10	11
10-20	156
20-30	79
30-40	34
40-50	14
50-60	6
60-70	4
70-80	4
80-90	0
90-100	2
100-110	0
110-120	0
120-130	0
130-140	1
140-150	1

NOTE: The 312 thirty-minute observations listed above represent only 6% of the total number of thirty-minute observations, and all of the other 94% are less than 15 ppb.

Table 13

30-Minute Hydrogen Sulfide Observations, Hoerner-Waldorf, Frenchtown, February 2, 1974 - May 16, 1974.

Range ppb	Number of Observations
0-10	60
10-20	100
20-30	50
30-40	29
40-50	31
50-60	10
60-70	8
70-80	7
80-90	2
90-100	3
100-110	3
110-120	0
120-130	0
130-140	1
140-150	1

NOTE: The 305 thirty-minute observations listed above represent only 11% of the total number of thirty-minute observations, and all of the other 89% are less than 15 ppb.

The University group sampled several areas in and around Missoula in 1973. A 115 ppb H_2S concentration was recorded in mid-July seven miles southeast of the mill. A 147 ppb reading was obtained at Target Range in May, 1974. Thus it might be surmised that spring and summertime levels can also be high even without the increased fall-winter inversion frequency.

At the Frenchtown gas chromatograph H_2S levels were considerably higher and violation readings more numerous than at the Target Range station. The Frenchtown station 2.7 miles NNW of the plant gave a high H_2S 30-minute reading of 168.8 ppb. This value was 5.6 times Montana's regulation level and some 34 to 56 times the odor threshold. On December 10, 1973, the people in the Frenchtown area were subjected to noxious HW odors for 19 hours. During 9.0% of the first two month period H_2S concentrations exceeded Montana's 30 ppb regulation level. The 168.8 ppb H_2S value would call for an 82% reduction to meet state standards.

Some 64% of the first two months of data at Frenchtown were recovered. The validity of this data was accepted on the same basis as that from the Target Range station. As time went on, proficiency in machine operation improved and a higher percentage of data collection is evident.

In mid-August, 1973, University sampling netted a 30-minute 209 ppb H_2S reading in the Albert Creek area across from the settling ponds, which would necessitate an 86% roll back. This ambient sample was taken considerably closer to the plant than the samples collected at the Frenchtown station.

Hydrogen sulfide sampling was not performed at the Rock Creek South station, as shown in Figure 7 . Diffusion modeling, however, predicted fairly high concentrations there under stable air conditions at present plant emission levels. Even with projected emission reductions as proposed by HW in its expansion program, minor H_2S violations on the hillside west of the plant are possible.

SULFUR DIOXIDE

Sulfur dioxide was collected both by the Federal Reference Method (West-Gaeke bubbler) and the gas chromatograph. Collection was made by HW at stations 1, 2, and 6 on Figure 7. Station 2, the hill station, was selected to monitor for sulfur oxide concentrations sufficient to cause the vegetation damage documented by the U.S. Forest Service (16).

On the stock Target Range gas chromatograph, a 12-second sample was taken during each three minute sampling cycle. Data is presented in Table 14.

Table 14

SULFUR DIOXIDE READINGS

3 minute observations	Frenchtown*	Target Range
greater than 25 ppb	21**	218
Approximate total observations	30,000	35,000
High 3-minute observation	49.2 ppb	58.5 ppb
High 30-minute observation	32.3 ppb	42.3 ppb
High 60-minute observation	16.2 ppb	41.8 ppb

* The modified Frenchtown G-C took one sample in 15 minutes upon its start-up on March 27, 1974.

** Two of these observations were in question.

At Target Range high values occurred on December 15 and 16, 1973, while most of the high Frenchtown readings occurred January 9, 10 and 11, 1974. Missoula weather on December 15 and 16 was cloudy, rainy with wind speeds less than 10 miles an hour, temperatures ranged from 29° to 41°F. On January 9, 10 and 11 the weather service reported snow and winds from calm to 20 knots accompanied by temperatures from -13° to 9°F.

During January 9-11 natural gas curtailment was in effect at the mill. Montana Power Company officials said that for the three days in question HW was asked to curtail its natural gas usage by at least 50% for 3, 10 and 13 hours on the respective days. Curtailment of natural gas necessitated the use of fuel oil which is higher in sulfur content and generally causes sulfur oxide emissions, which may explain the high readings on those days.

During December and January there were 197 more three-minute observations over 25 ppb at Target Range than there were at Frenchtown. This implies that there may be other sources of sulfur dioxide aside from the paper mill.

The highest recorded SO_2 value of 58.5 ppb (0.0585 ppm) over a three-minute cycle is much lower than the state one-hour regulation level of 0.25 ppm. No violations of sulfur dioxide standards were recorded during the sampling period which extended from November, 1973 to September, 1974. Wintertime brings lower inversion levels and more frequent air stagnation periods. If high sulfur oxide concentrations were ever present it is probable they would have been detected during the winter sampling period.

On the hill west of the pulp mill, the HW information was of questionable value. Wind recordings made at that site, #2 on Figure 7 , indicate that the sulfur dioxide bubbler results did not correlate with wind information. The highest reading (50 ppb SO_2) was recorded at a time when winds were in general from the NW. East winds are necessary if HW emissions are to be sensed at the hillside monitoring station, although drainage winds can bring the same pollutants past a given monitor twice within a short time period.

An April 10, 1974 visit to the sampling site by the State indicated that the SO_2 bubbler system had some flow difficulties. These sampling problems have been remedied.

Station #2 is located some 800 feet higher than the floor of the valley near the plant. Sulfation rate sampling was carried out by the U.S. Forest Service in conjunction with the State of Montana at various locations on the hillside generally west of the mill. Several sites at locations lower than station #2 recorded violation levels of Montana's reactive sulfur (sulfation) regulation. These sulfation plates are exposed for approximately one month in the field before they are chemically analyzed. An exposure period in July and August, 1973, gave a result of 0.9 mg $SO_3/100\ cm^2/day$ where the maximum standard for any one month period is 0.50 mg $SO_3/100\ cm^2/day$. November-December and January-February composite samples gave respective sulfation rate values of 0.065 and 0.03 mg SO_3/100 cm^2/day at the hill station #2. Winter monitoring gave no violations of sulfur dioxide or sulfation rate standards. During the summer of 1973 there were several violations of the sulfation regulation. Monitoring during spring and summer of 1974 did not detect SO_2 violations on the hillside.

Vegetation sampling conducted both by the U.S. Forest Service and the AOB gave increased sulfur concentration with decreased distance from the mill.

METHYL MERCAPTAN

Methyl mercaptan levels were first extrapolated from chromatograph charts as being the difference between the peaks representing total reduced sulfur levels and the peak measuring the combination of sulfur dioxide and hydrogen sulfide. Later, after the modification of the Frenchtown G-C, methyl mercaptan could be read directly. Table 15 shows methyl mercaptan concentrations. Some of the values are doubtful, as the company experienced many instrumental problems during instrument startup. Mercaptans are considered important since their odor threshold is some 10-20 times lower than that of hydrogen sulfide.

Sources of methyl mercaptan (CH_3SH), dimethyl sulfide $(CH_3)_2S$, dimethyl-disulfide $(CH_3)_2S_2$, hydrogen sulfide (H_2S) and total reduced sulfur (TRS) are presented in Table 16 as supplied the state by Hoerner Waldorf (17). Methyl mercaptans account for some 21% of the present total emission from foul condensates.

Suspended Sulfates

Stack testing by the state and HW on the lime kilns and the recovery furnaces showed high concentrations of sodium and sulfates and very low to zero concentrations of lead, cadmium, zinc, iron, magnesium and calcium. It was anticipated that the calcium would have been fairly high in concentration. The chemical analyses were done by flamed atomic absorption in the state laboratory in Helena.

Table 15

Frenchtown methyl mercaptans (MeSH)

Date	No. observations above 15 ppb	High 3-min Observation	High 30-min Observation	High 60-min Observation
Dec. 11	18	39.9 ppb	26.3 ppb	19.0 ppb
Dec. 12	24	49.4	24.4	18.9
Dec. 13	9	47.5	19.6	9.8
Dec. 18	5	45.7	9.7	4.8
Dec. 19	3*	145.7	64.4	32.2
Dec. 21	17	30.0	21.8	8.1
Dec. 22	42	35.0	26.3	16.7
Dec. 23	6	22.3	17.1	10.2
Dec. 28	7*	32.9	26.9	15.3
Dec. 29	1*	36.8	--	--
Dec. 30	1*	73.7	--	--
Jan. 1	1	19.7	--	--
Jan. 10	1*	26.1	--	--
Jan. 14	2*	77.7	--	--
Jan. 15	3	32.1	13.7	6.9
Jan. 16	10	33.1	24.1	20.9
Jan. 18	1*	23.0	--	--
Jan. 19	5	28.7	15.6	7.8
Jan. 24	1	17.4	--	--
Feb. 10	1	--	34.1	--
Feb. 11	6	--	48.8	--
Total **	164	145.7	64.4	32.2
Target Range methyl mercaptans				
Dec. 10	1*	17.9	--	--
Dec. 16	17*	54.5	21.7	14.4
Dec. 17	10*	24.9	18.2	13.0
Dec. 26	1*	26.3	--	--
Jan. 8	1*	21.6	--	--
Jan. 9	3*	35.5	--	--
Jan. 10	3*	58.0	22.7	11.4
Jan. 21	2*	31.3	10.3	5.1
Jan. 22	2*	42.0	14.0	7.0
Total **	40	58.0	22.7	14.4

*Doubtful data - all other MESH readings had high H_2S readings in equivalent time periods.

From February 12 to May 16, there were no mercaptan readings above 15 ppb at the Target Range monitor.

**Last three columns are recorded high observations.

Table 16

PRESENT MILL - FOUL CONDENSATES

SULFUR COMPOUNDS EMITTED (LB H_2S/DAY)

CONDENSATE STREAM	TRS	CH_3SH	$(CH_3)_2S$	$(CH_3)_2S_2$	H_2S (by Diff.)
Concentrator hot well	280.8	5.5	0.4	15.2	259.7
#1-#2 Evaps hot well	850.7	0.0	4.6	21.1	825.0
#4 Evaps hot well	803.5	593.1	61.2	38.3	110.9
Hogger jet	267.8	1.0	0.8	4.7	261.3
Accumulator	162.0	0.8	55.1	5.9	100.2
Turpentine Decanter					
During batch blow (1/6)	84.0	0.6	3.1	0.4	79.9
Between blows (5/6)	388.8	2.4	13.3	1.8	371.3
TOTAL	2837.6	603.4	138.5	87.4	2008.3

FOUL CONDENSATE EMISSIONS

Expanded Mill

Compound	Emission Without Stripping lb/day as H_2S	Stripping Efficiency %	Emissions After Stripping lb/day as H_2S
CH_3SH	959	86	137
$(CH_3)_2S$	220	78	48
$(CH_3)_2S_2$	139	72	39
H_2S	3,192	93	227
	4,510	90 ave.	451

Table 12A

Recent experimental evidence (18) indicates that the oxidation of sulfur dioxide to sulfates can be accomplished by finely divided carbon (soot) particles. Hoerner Waldorf's hogged fuel boiler could certainly provide this catalyst. In view of acid aerosol sampling it is probable that much of the SO_2 is oxidized to sulfuric acid.

The Montana ambient air quality standard for suspended sulfate is 4 micrograms per cubic meter of air, as a maximum allowable annual average, and 12 micrograms per cubic meter of air, not to be exceeded over 1 per cent of the time.

Table 17 shows the arithmetic mean concentration of suspended sulfates at the Missoula County Courthouse for 1973 was 3.5 ug/m^3 which is approaching the Montana standard for suspended sulfates. The courthouse had ten days exceeding 12 ug/m^3. The high reading was 19.3 ug/m^3. Seven days exceeded the one percent of the time state standard.

So far in 1974 the Missoula County Courthouse has had two days exceeding 12 ug/m^3. Table 17 shows that suspended sulfate concentrations are in general higher at Johnson Bell Field than at the courthouse in Missoula. Observations by AQB personnel from the ground and the air indicate that HW emissions generally follow the sides of the valley as they drift toward Missoula rather than drifting toward the air field through the valley center which would account for lower sulfate concentrations at Johnson Bell Field.

Urban centers such as Missoula are known to have some sulfate concentrations even without specific sources such as the pulp and paper mill.

Sulfates recorded by HW at Target Range, Frenchtown and the hill station, #2 are shown below in Table 18 .

Table 18

SUSPENDED SULFATES AS COLLECTED BY THE COMPANY

Station	Number of Observations	High Value (ug/m^3)	Two month's plus Average (ug/m^3)
Target Range	42	6.20	2.15
Frenchtown	43	4.95	2.09
Hill Station	28	7.60	3.31

Table 17

SUSPENDED SULFATES
Information Gathered by Missoula City-County Health Department
Values in micrograms per cubic meter of air (ug/m^3)

Month	COURTHOUSE Month's Avg.	COURTHOUSE High for Month	JOHNSON BELL FIELD Month's Avg.	JOHNSON BELL FIELD High for Month
January, 1973	4.6	14.1 (2)*	7.6	21.4 (9)
February, 1973	6.6	19.3 (6)	9.0	22.0 (5)
March, 1973	2.0	4.5	2.7	8.4
April, 1973	3.1	9.3	4.6	11.7
May, 1973	2.8	6.4	4.9	10.0
June, 1973	2.1	4.6	4.4	9.0
July, 1973	2.8	5.0	5.9	14 (2)
August, 1973	3.1	5.1	3.3	7.1
September, 1973	2.1	4.7	4.0	9.7
October, 1973	4.7	7.3	3.5	7.9
November, 1973	3.3	6.5	3.5	10.4
December, 1973	4.5	13.5 (2)	3.4	14.0 (2)
January, 1974	2.7	7.3	3.7	9.5
February, 1974	4.7	12.4 (1)	4.1	10.3
March, 1974	6.8	10.2	2.9	6.0
April, 1974	4.7	12.4 (1)	3.1	7.1
May, 1974	3.4	6.0	1.7	3.6
June, 1974	5.4	9.0	2.7	5.6
July, 1974	3.4	5.8	4.0	8.2
August, 1974	3.1	5.4	4.1	7.6
September, 1974	3.1	7.0	4.1	10.7

*Number in parenthesis gives the total number of values over 12 ug/m^3 (24-hr. violation level)

Courthouse and Johnson Bell Field respective annual averages Jan., 73 to Sept. 1974 were 3.76 and 4.15 ug/m^3. The annual violation level is 4.0 ug/m^3.

A trend is evident in Table 18. Noting that the hill station is closest to the plant and Target Range farthest, it is fairly clear that average sulfate concentrations increase as one approaches the plant. The highest sulfate value recorded by HW was on the hillside near the plant.

The AQB and City-County Health Department ran particle sizing monitors, total suspended particulate (high-volume) samplers and a membrane sampler during April, 1974 at locations shown in Figure 7 and indicated below in Table 19.

Table 19

SHORT-TERM PARTICULATE MONITORING

Station	Type Sampler	Location in Figure
Fairbanks	A,B,C,D	#3
Johnson-Bell Field	A,C	#4
Miller Residence	A	#5
Target Range	A,B,C,D	#6

A - high volume sampler (total suspended particulates)
B - membrane sampler (chemical analysis of particulates)
C - cascade particle sizing sampler (particle sizing and chem. analysis)
D - wind instrument

Data was collected during this sampling to give good trend information.

Primarily samples were taken to check suspended sulfate levels and particle sizes in relation to distance from the mill. One total suspended particulate value of 320 ug/m^3 was obtained on April 22, 1974 at the Fairbanks location, 1.4 miles due south of the plant.

Particle sizing data were quite significant. SDHES found that the mean mass diameter (MMD) of particulate matter in the air decreased as the plant was approached from the southeast. Larger particles are found in the Target Range area and smaller particles near the plant as shown below.

MMD (microns)	Site
2.7	Target Range
3.9	Johnson Bell Field
2.0	Fairbanks

Sulfate analysis of the different particles sizes gave the following

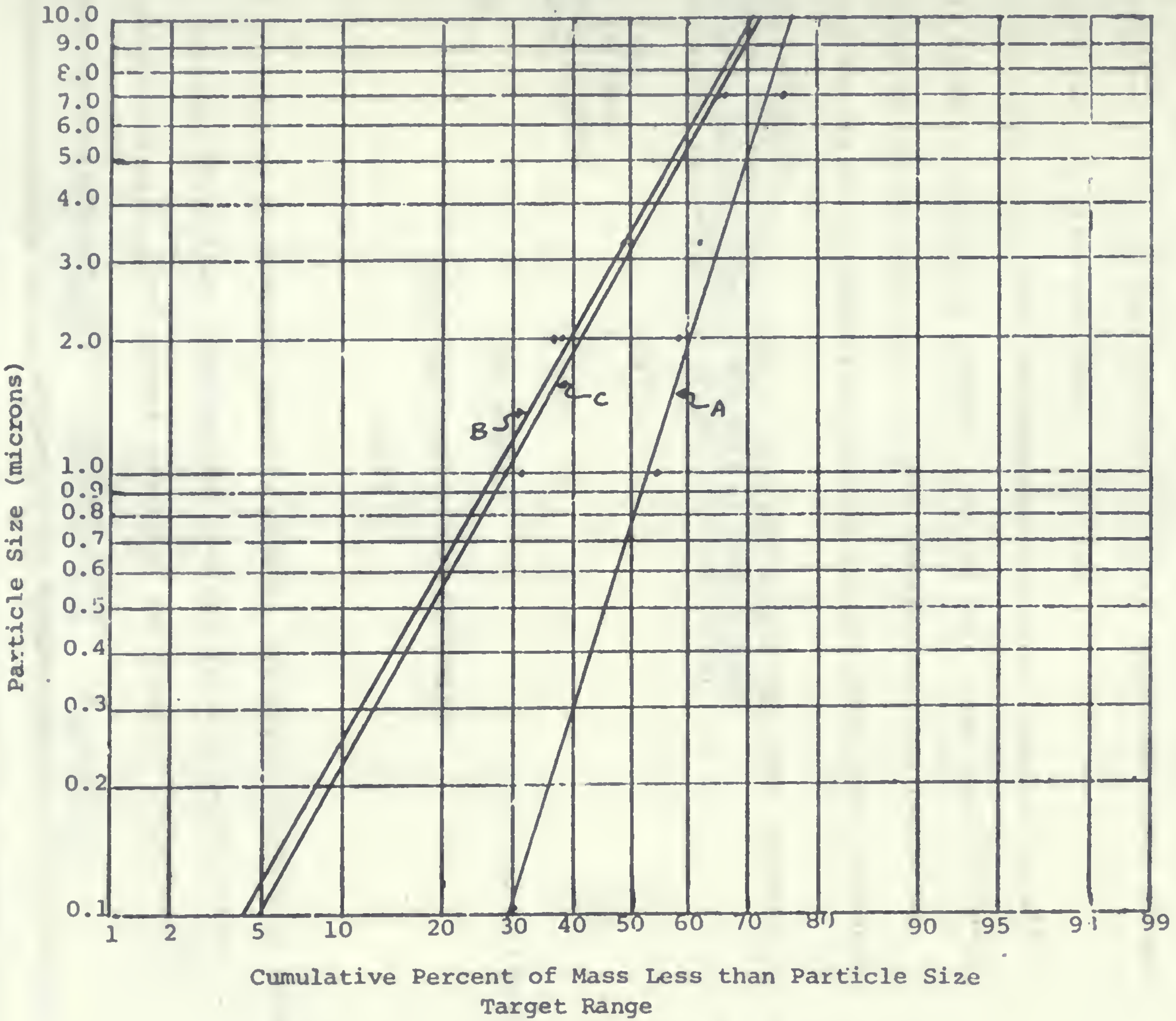


Figure 8

Key-Sampling Period
A 24-hr. MMD = 0.8
B 72-hr. MMD = 3.5
C 96-hr. MMD = 3.5
Weighted Average MMD = 2.7

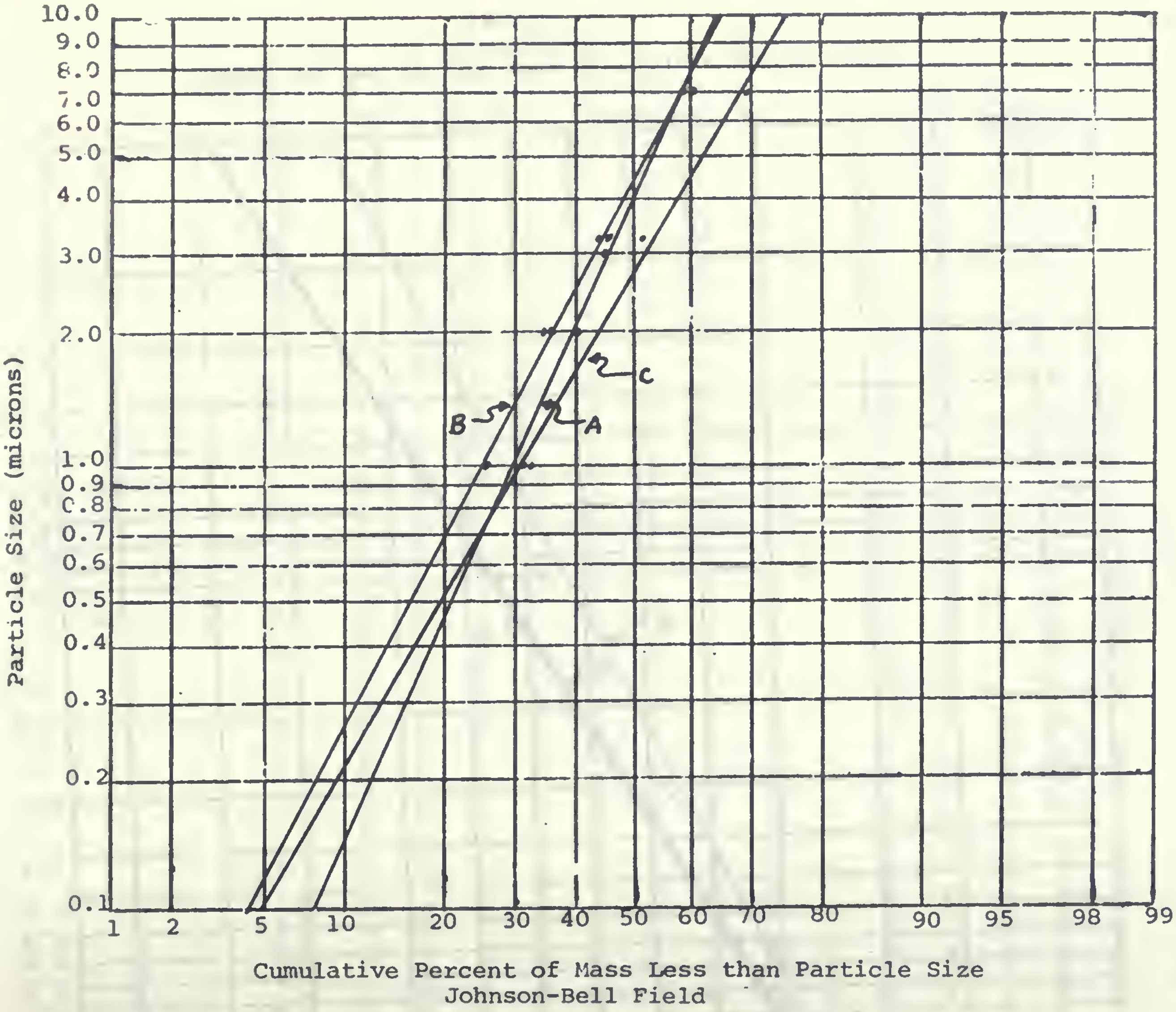
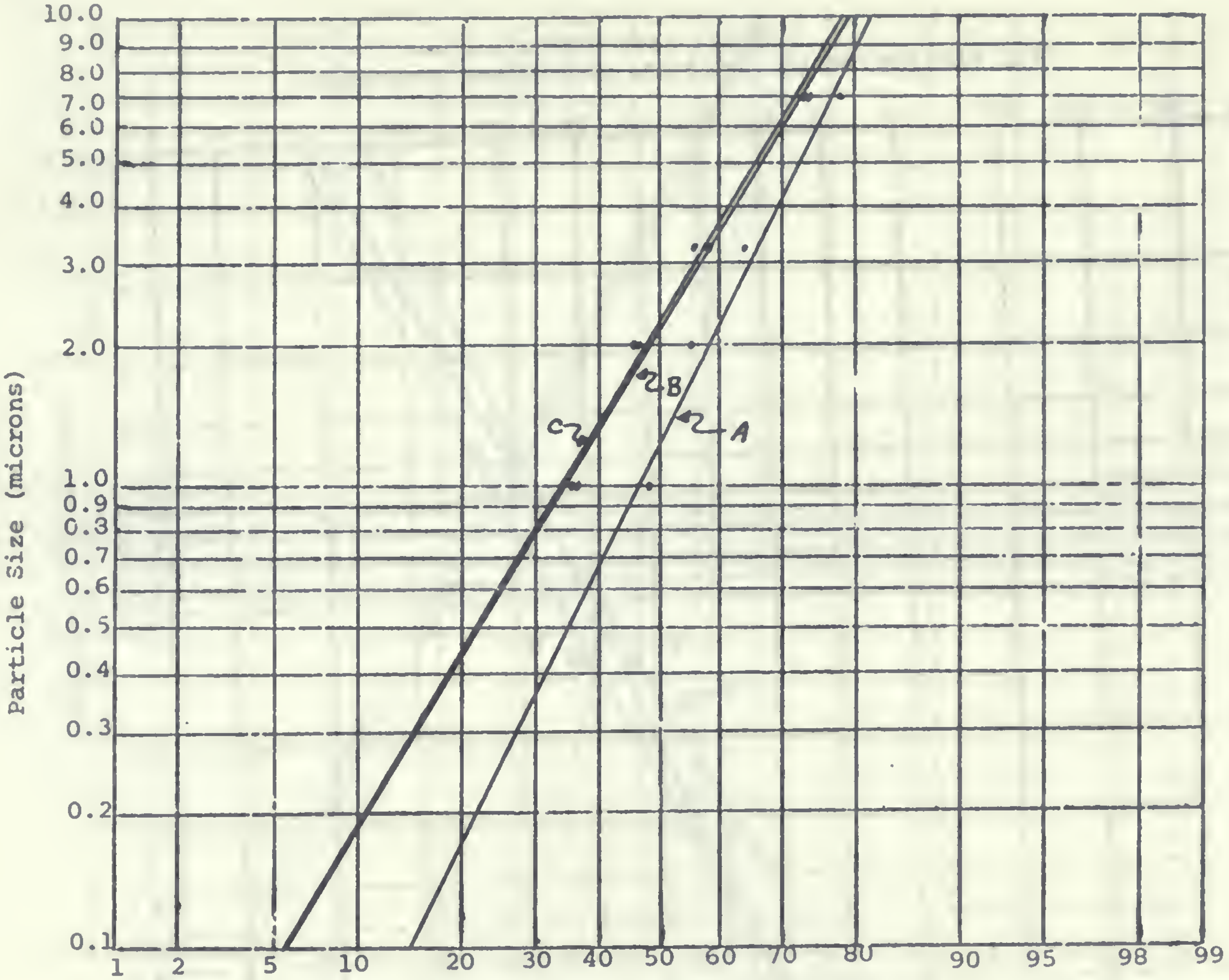


Figure 9

Key-Sampling Period
A 24-hr. MMD = 4.1
B 72-hr. MMD = 4.5
C 96-hr. MMD = 2.9
Weighted Average MMD = 3.9



Cumulative Percent of Mass Less than Particle Size
Fairbanks
Figure 10

Key-Sampling Period
A 24-hr. MMD = 1.5
B 72-hr. MMD = 2.2
C 96-hr. MMD = 2.2
Weighted Average MMD = 2.0

information for the Fairbanks location April 17-24, 1974.

	Particle Size	Sulfate Concentration
Stage 1	7.0 microns plus	0.31 ug/m^3
Stage 2	7.0 - 3.3	0.23
Stage 3	3.3 - 2.0 μ	0.27
Stage 4	2.0 - 1.1 μ	0.39
Stage 5	Submicron	2.43

μ is the symbol for a micron (a unit of length equal to one millionth of a meter (39.37")

The data show that most of the particulates are very small near the pulp-paper mill and that the sulfate concentration increases as the size of the particle decreases. Figures 8 , 9 and 10 depict composite data for the three cascade impactor monitoring sites operated from April to Sept. of 1974. Some 30-50% of the particles are one micron or smaller in size. This is the size range which leads to respiratory problems since these small particles can penetrate into the lungs. High concentrations of very small sulfate particles in the Missoula Valley are a potential health hazard.

PARTICULATES

The Missoula Valley is included within the Montana Air Quality Control Region which is required by the State Implementation plan to enforce stringent airborne particulate control. A history of high recorded total suspended particulate values in the area led to this stringent classification.

Table 20 shows a trend for the Missoula Valley.

Table 20

COMPARISON OF TOTAL SUSPENDED PARTICULATE LEVELS IN MISSOULA
(values in micrograms per cubic meter)

Year	No. of Samples	Arithmetic Average	Max. 24-hour Average
1961-62	115	158	666
1971-72	362	86	269
1972-73	360	76	261

cont.

Year	No. of Samples	Arithmetic Average	Max. 24-hour Average
1973-74	270	80	914
1971-74	992	81	914

The 1961-62 data were obtained at the Federal Building in Missoula and the 1971-74 data all comes from monitoring equipment on the courthouse. The two locations are reasonably close together in downtown Missoula. The annual averages were used for comparison since the early data couldn't be converted to geometric averages as the standards require. The change downward from 1962 to 1971 was due mainly to the removal of tepee burners from Missoula lumber mill operations, but it is important to note that present particulate emissions in downtown Missoula are close to federal primary standards (75 ug/m^3 annual geometric average). An 81 ug/m^3 arithmetic average roughly equals 73-75 ug/m^3 geometric average.

Numerous concentrations above the 24-hour federal and state standards have been observed within the valley.

How much HW contributes to the Missoula particulate level, and whether the plant expansion would add to the particulate concentrations in Missoula remains moot.

During the November - January sampling in the valley the following values were obtained as in Table 21.

Table 21

Particulate Data Summary in ug/m^3

Hoerner-Waldorf Data - November 1973 to September 1974

	Geometric Avg.	Max. 24-hr value
Target Range - Sta. #1	45	236
Hill Sta. - Sta. #2	17	166
Frenchtown - Sta. #3	35	133

(cont. on next page)

(cont.)

	Geometric Avg.	Max. 24-hr value
Montana State Data - April, 1974 to September, 1974		
Miller Residence	47.2	93
Fairbanks	34.0	320
Target Range	59.4	200
Missoula City-County Health Department - November, 1973 to September, 1974		
Target Range	31.2	211
Johnson-Bell Field	36.9	290

One reading (320 ug/m^3 - 24-hr. average) was obtained at the Fairbanks Residence, 1.4 miles south of the plant by the state on April 22, 1974. Eventually the national secondary standard of 150 ug/m^3 will be enforced. Even the hill station had a reading over 150 ug/m^3. Thus the particulate problem will still remain even though present particulate emission levels will presumably be held constant.

VISIBILITY AND ACID AEROSOLS

Considerable impairment of long range visibility has been observed in the Missoula Valley. Many days during the year the mountains surrounding the Missoula valley are obscured.

This impaired visibility is probably not measurable in economic terms, but it is an unpleasant reminder of HW's pollution of the air. Most residents of the scenic Missoula area probably would agree that they should not unnecessarily sacrifice their view for HW's benefit.

Particulate matter in the size range of 2 microns and smaller comprise 40-60% of the particulates in the Missoula air. Considering that particles 0.02 to 2 microns account for most of the visibility reduction (19), it is understandable that Missoula has visibility problems.

On April 17, 1974 readings were made in the Missoula Valley with an airborne nephelometer. The nephelometer was used to measure the light scattering that morning. Table 22 gives data which show the visibility to be reduced to 11.5 miles in HW area. It was noted later that the instrument has

Table 22

NEPHELOMETER DATA FOR MISSOULA VALLEY 4/17/74

Area	Scattering Coef. (M-1)	Visibility (miles)	Number of Readings
H-W Plume	28.6×10^{-3}	11.5	8
H-W Ponds	22.6×10^{-3}	14.3	5
Van Evans Plume	22.5×10^{-3}	13.0	3
Evans Products Plume	2.15×10^{-3}	15.0	1
Frenchtown Haze Layer	27.1×10^{-3}	11.8	4
Mill Creek Area	15.7×10^{-3}	21.4	7
NE Side of Valley (Foothills)	13.6×10^{-3}	26.0	17
Missoula	12.2×10^{-3}	30.6	9
Airport	14.0×10^{-3}	24.6	3

been operated on a less sensitive range than should have been used. Consequently, the reduction of vision in miles are probably worse than measured.

Evans products and the Van Evans mill both contribute to the visibility reduction in the Missoula area, but visual observation and instrument readings indicated that HW was primarily responsible for the poor visibility in the Valley on April 17, 1974.

Even though most of the visible plume from the plant is steam, considerable amounts of particulate were seen coming from the mill. An indication of equivalent particulate mass loadings was also given by the nephelometer which indicated a very high concentration of very small particles over the plant and out from the plant for several miles.

At higher altitudes it was impossible to see the valley floor due to plant emissions. It appears that pilots could experience great difficulty in landing in the valley.

Airborne measurements of cloud condensation nuclei (CCN), total particle counts and particle size were made in the vicinity of a large Kraft pulp and paper mill which is near Port Townsend, Washington. (20)

The authors said that considerable quantities of hygroscopic particles (eg. Na_2SO_4, $CaSO_4$, H_2SO_4) are emitted into the atmosphere from these plants. They discovered plume particulates 40 km. downwind to have fourfold higher particle concentrations than non-plume ambient air. In addition to a large plume peak concentration of CCN (particles 0.05 to about 1 micron diameter (21) corresponding to a downwind travel time of four hours, a peak for total particulates was found after about 2 hours of plume travel.

The observed build-up in the plume of particulates some distance away from the pulp-paper mill may be what is observed in the Missoula Valley air. With a 3-5 mile-per-hour light wind in the Valley, two to four hours of plume travel could result in a particulate build-up 6 to 20 miles from the pulp mill, a distance range that would include the city of Missoula.

This increase in particulate size as the plume travels away from the source is enhanced by humidities above 85%. The resulting aerosols would be high in sulfates due to sulfur dioxide-ammonia-water reactions (20) and inherently high pulp mill sulfate emissions.

It might be expected that diffusion would be the main mechanism to cause a decrease in particulates as they tend downwind in a plume. The authors, however, point out that gravitational settling should be unimportant or a time scale of a few hours since even a particle as large as 3 microns has a fall speed of only about 100 microns per second or 1.08 meters downward in these hours. (20)

Aircraft sampling was performed early in October, 1974 for acid aerosols. A light to moderate inversion was extant and the #4 recovery boiler was down during the total time of the sampling. The setup consisted of a bracket for externally mounted filter holders into which were placed mitex (teflon), nucleopore and Whatman #41 filters. Air drawn through the filters passed through a dry test meter before reaching the vacuum pump. The aircraft circled close to the plant at various altitudes.

Two different chemical analysis methods were used to obtain corrolative results. (22) (23) Sampling on two different flights obtained readings of 17 ug/m^3 over the pulp-paper mill at altitudes which appeared to place the samplers directly in the layered cloud of plant emissions. Further sampling should and will be accomplished.

Communications with Drs. West, McAdie and Barton indicate that acid aerosol values of 3-5 ug/m^3 are moderate whereas values up to 10 ug/m^3 might be considered fairly high.

High concentrations of sulfuric acid aerosol have over the years since Hoerner-Waldorf's entrance into the valley caused powerlines to be pitted and be reduced in size, relays and switches to malfunction resulting in power outages in the valley near the pulp mill. (24) These problems are not evident in valleys somewhat removed from the Missoula Valley. Many other acid-related corrosion problems could be mentioned (eg. deterioration of paint, barbed wire fences, and etc.) and documented.

BARTON TITRATOR CALIBRATIONS

All the emission data in this impact statement was furnished by the company. To check the validity of the data, a team from the AQB performed a series of unannounced tests on the efficiency of the Barton Titrators used by HW to monitor emissions.

The first step in the testing was injecting known amounts of H_2S and SO_2 into the monitor, then noting the readings on the recorder trace. Next, the same concentrations were injected into the sample lines where they attached to the stacks, and the recorder trace again was noted. These tests disclosed several problems with the test system. First, it was noted that some of the sample lines were over 100 feet long and had places where moisture from stack emissions could collect and partially scrub out the gases being monitored. Also, several leaks were found in the sample lines. Table 23 contains the data collected in the testing.

Table 23

EFFICIENCY OF HW BARTON TITRATORS
April 19, 1974

Barton Titrators	Efficiency
Recovery Boiler #3	
H_2S	81.5%
SO_2	84.6%
Recovery Boiler #4	
H_2S	91.7%
SO_2	0
No. 2 lime kiln	0

The table shows that during the days of the inspection the monitoring equipment was recording only 80 - 90% of the total emissions. In two cases where the monitors appeared to be functioning properly, they actually were not recording actual emissions. The testing was done the week of April 16-19, and a considerable effort has since been expended by the company to correct difficulties noted during the inspection. New data has since been given the state to update previous emission data.

POND SAMPLING

AQB personnel tried to determine relative pollutant concentrations in pond emissions. Sampling in a boat on Pond #14 was conducted as a 5-10 mph west wind was blowing to eliminate possible influence of mill emissions.

Teflon bags were used to carry samples to the chromatographs and were purged with nitrogen gas to eliminate any sampling error. Limited time was allowed between bag sampling and gas chromatographic analysis at HW's Frenchtown monitor.

Analysis results are given in Table 24 . Complete calibration of the gas chromatograph was not performed so the data should be considered approximate.

Table 24

HW AMBIENT POND SAMPLING
April 19, 1974

Component of Pond Emissions	% of Total Pond Emissions
Total Sulfur	100
Dimethyl sulfide	2.0
Hydrogen sulfide	71.4
Sulfur dioxide	0.5
Methyl mercaptan	3.0
Unidentified substance (possibly carbonyl sulfide)	1.0
Undifferentiated remainder	22.1

Dimethyl disulfide definitely was not present; but other higher molecular weight sulfur compounds possibly represent the 22.1% unknown fraction. The instrument gave only one unidentifiable peak as noted.

AIRBORNE SAMPLING

Samples were taken by airplane from the air directly over and immediately around the HW complex along with air samples taken some 50 to 75 feet above the pond water level. Wind speed was low and generally from the west. Gas chromatographic analysis of the bag samples are shown in Table 25.

Table 25

AIR SAMPLES TAKEN OVER THE PLANT AND PONDS
April 18, 1974

	Sample from over the Plant	Samples from over the Pond
Total Sulfur	100%	100%
Hydrogen sulfide	57%	76%
Sulfur Dioxide	35%	5%
Unaccounted	8%	19%

OXIDATION OF SULFUR COMPOUNDS

Very little information is available pertaining to Missoula Valley conditions. Most of the studies relate to the oxidation of hydrogen sulfide by ozone (25) (26). Although ozone levels have not been characterized around Missoula, it appears from the literature that the lifetime of H_2S in the atmosphere is approximately 2 hours when the ozone content of 0.05 ppb and particulate is $15,000/cm^3$ (these conditions are typical of continental air).

The oxidation of hydrogen sulfide to sulfur dioxide to sulfate and possibly dilute sulfuric acid probably occurs in the HW vicinity, but it is difficult to quantify such transformations on the basis of existing ambient air data. Other sulfur compounds probably undergo the same of similar oxidation processes.

HEALTH EFFECTS

There would be no predictable health effects from the liquid discharge of the expanded plant. The possible health effects of the increased air pollution by the expanded plant as proposed, on the other hand, would be a matter of considerable concern.

Following publication of the draft statement, physicians, sufferers of respiratory ailments and members of the public in Missoula pointed out their concerns over possible health effects of the present mill and the proposed expansion. Among their concerns were the following:

1. Humidity. Presently, HW contributes large amounts of water emissions to the Missoula Valley airshed. With the proposed expansion, the amount of emitted water would more than double to some 25 to 30 million pounds per day. This increase in moisture in the Missoula air would increase the average relative humidity and incidence of fog.

Since 1958 (the pulp and paper mill began operations in 1957), the level of relative humidity at Missoula was increased (27). On the other hand, review of fog data collected at the airport suggests a declining trend in fog incidence in recent years may be occurring (28). Several more years of data are needed to determine whether the decline is permanent or if the occurrence of fog is cyclic. However, it seems definite that average fog incidence at Missoula has increased since 1958 to levels not characteristic of natural phenomena. Plant expansion with increased water emissions might further increase the relative humidity and the incidence of fog.

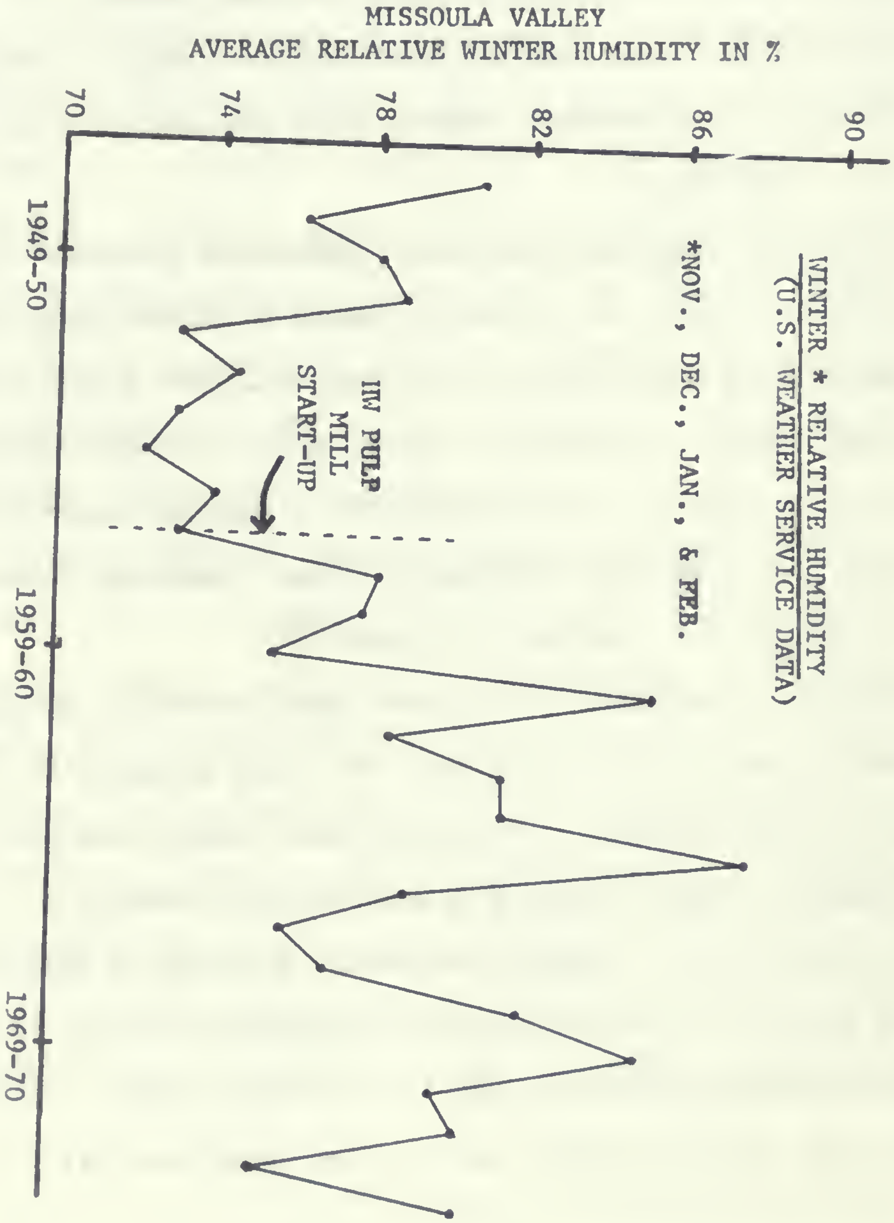
It is probable that particulate controls installed by HW over the last few years have reduced the suspended particle concentrations in the air. These particles function as nuclei upon which droplets of moisture condense to form fog or rain. This particulate reduction might explain the recent decline in fog occurrence, although fog incidence still may be higher than normal.

Over twenty years of winter relative humidity data recorded by the U. S. Weather Service in Missoula are indicated in figure 11. A correlation between winter relative humidity and death—involved pneumonia (27) has been noted. A British physician has correlated respiratory illness with "indoor dryness"--the difference between indoor and outdoor relative humidity in relation to temperature.

This physician theorized that winter temperature depression lowers the absolute moisture content of outdoor air enough to exceed normal physiological compensation capabilities. So winter air, even at high relative humidity, when heated to normal indoor temperature, becomes dessicated beyond the body's ability to fully rehumidify it during inhalation without some strain. This aggravates respiratory tissue, rendering it more susceptible to infection or respiratory illness (29).

Dr. Donald F. Proctor (30) has studied human perception of humidity under controlled temperature conditions. His study disagrees with the above discussion and indicates that people cannot readily perceive relative humidity change although they may have the sensation of temperature change even if temperature remains unchanged as humidity varies. Dr. Proctor feels that the human body has a remarkable ability to adapt to changes in relative humidity, even to very low humidity. He said it is unlikely that altered humidity can have any significant effects on health (31).

Figure 11


MISSOULA VALLEY
AVERAGE RELATIVE WINTER HUMIDITY IN %
70
74
78
82
86
90
WINTER * RELATIVE HUMIDITY
(U.S. WEATHER SERVICE DATA)
*NOV., DEC., JAN., & FEB.
HW PULP
MILL
START-UP
1949-50
1959-60
1969-70

It seems logical that pneumonia deaths should increase in the winter months with or without humidity effects due to the usual winter time increased incidence of respiratory illnesses such as the common cold.

High humidity is more conducive to acid aerosol formation where sulfur dioxide and (very probably) reduced sulfur compounds are present.

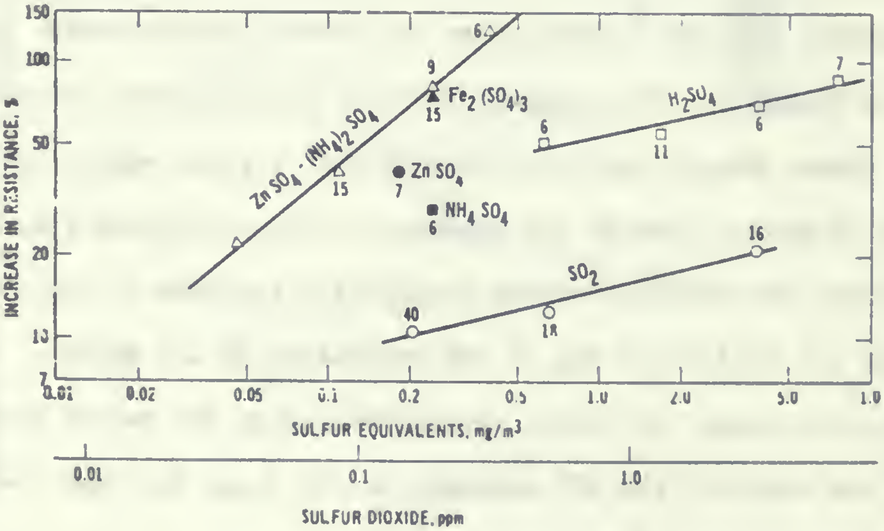
2. Sulfuric Acid Aerosol, Sulfur Dioxide and Sulfates. Numerous references are made to deleterious health effects of sulfur dioxide, sulfuric acid and sulfates (32),(33), (34). It is implied that particulates are an integral part of this discussion since submicron to micron particles are the nuclei upon which the sulfur dioxide gas condenses to form the sulfate and sulfuric acid aerosol oxidation products.

Although sulfur dioxide concentrations in the vicinity of the HW plant are low, their health implications should be assessed in terms of their potential for formation of more irritant substances. Particulate oxidation products of sulfur dioxide (sulfates or acids) generally have much greater irritant potency than the parent sulfur dioxide gas, as indicated in figure 12. This comparative work was performed on guinea pigs.

A casual glance indicates clearly that a given amount of sulfur present in sulfur dioxide gas produces a lesser irritant response than the same amount of sulfur in either particulate sulfates or sulfuric acid. One part per million of SO_2 is the equivalent of 1.3 mgS/m^3. When present as SO_2, this amount of sulfur causes changes in the smooth muscles that narrow the lumen of the air passages in the lung, increase the resistance to air flow by about 15 percent.

If through reaction in the atmosphere this sulfur equivalent were converted to 0.7 micron mean mass diameter sulfuric acid mist, it could produce an increase in resistance of about 60 percent representative of a four-fold potentiation of irritant response (35).

Figure 12



Comparison of irritant potency of sulfur dioxide and sulfur-continaing particulates. Numerals beside each point indicate number of animals.

Data generated by Amdur (32) suggests that the 5000 pounds of SO_2 emitted daily by HW would lead to the formation of about 170 pounds of airborne sulfuric acid. Much of this probably would be neutralized by emissions from the lime kilns.

High HW sulfate levels also must be considered. An EPA-CHESS study (36) reports that in the Salt Lake Basin and during warm weather, the threshold for aggravation of asthma by suspended sulfates was 1.4 ug/m^3.

A significant contribution to the information relative to the sulfate problem in the Missoula area was made by the University of Montana Student Environmental Research Center (37). It found for a 21-month period (September 1970 to June 1972) when both hospital admission and total suspended particulate data were available that there was a moderate to strong correlation between measured winter month soluable sulfates and winter time hospital respiratory admissions. The strongest correlations relate to people less than 20 years of age or greater than 64 years.

3. Trace Elements. Trace and toxic elements have not been found in the HW area despite analysis of many air samples from the vicinity. Chemical analyses have been run for iron vanadium. Samples were collected by in-plant stack sampling and by particulate collection devices at the airport, in the target range area, and one mile due south of the mill. The absence of these trace metals eliminates concern about some dangerous sulfate compounds, although background ammonia in the air probably would give rise to ammonium sulfate.

4. Hydrogen sulfide. Hydrogen sulfide ranks high as a toxic agent. It causes eye and respiratory tract irritation and deleterious effects to the nervous system (38).

Complaints include conditions of nausea, loss of apetite, fatigue (39), labored breathing. Dr. Tom Shimpke, in his hearing statement, August 3, 1974, referred to Missoula residents who are adversely affected by air pollution from the HW plant--people who suffer great discomfort in breathing similar to trying to exhale through a closed fist (40). Certain people within the population are particularly sensitive to hydrogen sulfide because of various diseases, metabolic disorders or psycological disturbances. Although investigations of the effects of hydrogen sulfide on hypersensitive or disabled persons are limited some authorities (38) have noted how such pollutants act on persons with such health problems. First, individuals with eye or respiratory tract problems, such as conjunctivitis, eye infections, emphysema, viral pneumonia and bronchitis, may suffer from H_2S. Dr. Richard Beighle, an ophthalmologist practicing in Missoula, stated that he sees acute and chronic conjunctivitis everyday in his practice, which is related to air pollution effects on the eye (41).

Secondly, anemics appear to constitute another vulnerable group since detoxification of hydrogen sulfide relies on oxygen in the blood. If the red blood cell count is low, the blood oxygen content is low.

Thirdly, alcholics have been overcome after drinking by unusually small concentrations of H_2S, indicating that alcohol and H_2S do not mix.

Fourth, persons with psychiatric problems may suffer stress at any H_2S level.

Fifth, infants may be particularly sensitive to low H_2S concentrations. Concentrations above 72 ppb have produced complex symptoms of undernourishment, delayed growth, general weakness and retarded physical and neurophysical development and gastro-intestinal disturbances.

Since hydrogen sulfide is rather insoluble (42) in an aqueous medium, it can penetrate further into the lungs (to the alveoli) than SO_2 or acid aerosols which generally are absorbed into the mucosa of the mouth. This property makes H_2S a more serious irritant.

Hydrogen sulfide in combining with the moist tissues of the eyes or respiratory mucosa undergoes reaction with alkali of the tissues to form sodium sulfide, a caustic irritant which is probably responsible for the irritative effects of H_2S (38). General detoxification occurs when oxygenated hemoglobin with enzymic catalysis form thiosulfate or sulfate which are eliminated through the kidneys. This detoxification process appears to be very rapid, peventing H_2S from accumulating. However, high concentrations in the air cannot be tolerated by the body and can result in death (38).

As discussed earlier, increased humidity is significant as a contributing factor in increasing the irritative effects of hydrogen sulfide and particulates or sulfur dioxide.

EFFECTS ON LIVESTOCK

Although it is not clear what causes respiratory difficulties (asthma) in Frenchtown area cattle, the difficulties are noted by several Missoula veterinarians.

This higher than normal incidence of asthma in cattle in the HW plant vicinity may result from substances in the soil, the drinking water, the fertilizer applied to the pastured field, and/or the grass or hay eated by the animals (43).

It appears that sulfur can to a certain extent act as a fertilizer enhancing vegetive growth (43). This growth may be abnormal with increased tryptophane or other metabolities generated within the plant tissue.

When eaten and metabolized by cattle, a metabolic product (3-methyl-endol) can be generated which is suspected (44) of being asthma causative in cattle.

Wheatgrass samples collected around the HW plant yielded an average for four samples of 1380 ppm* whereas seven samples collected in the Ovando area gave an average of 885 ppm. Thus, the wheatgrass in the HW area is some 55 percent higher in sulfur than in the control area.

HW's H_2S emission levels presently are very high. Some 366 violations of Montana's 30-minute standard of 30 ppb have been noted with the highest recorded concentration being 147 ppb at a point 9.67 miles from the pulp and paper mill.

The Illinois Institute for Environmental Quality recommends an eight-hour average standard for hydrogen sulfide of 0.015 mg/m^3 (10.7 ppm) (38). At the Frenchtown and target range monitoring sites, eight-hour averages of 59.4 and 52.0 ppb respectively were recorded last winter (December 1973). Missoula residents endured concentrations five times those recommended as maximum by the state of Illinois.

In view of the 10.7 ppm eight-hour recommended standard, Montana's 30-minute standard of 30 ppb may be set too high.

---

*Samples analyzed chemically by U of M Botany Department by Phil Tourangeau for sulfur content.

B. Water Quality

GROUNDWATER

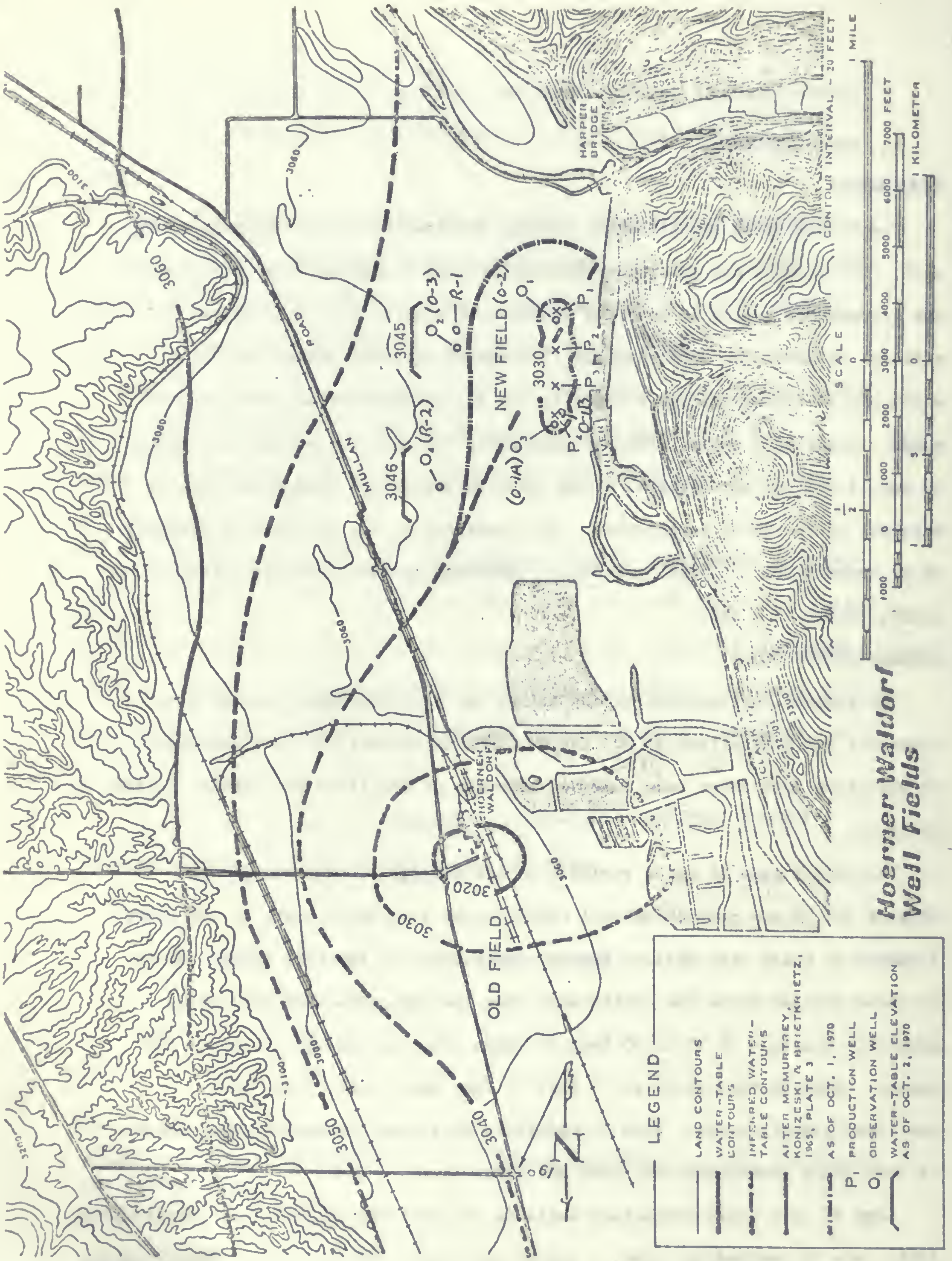
The HW operation significantly affects groundwater in the vicinity of the mill. The company has two production well fields producing about 18 mgd and the groundwater system is used for disposal of a majority of the liquid effluent (Figure 13). Approximately 15.8 mgd of effluent leaves the plant daily and is routed through a clarifier to 14 interconnecting stabilization ponds. About 10.0 mgd of effluent percolates through pond bottoms with ponds 14 and 15 and two experimental rapid infiltration basins accounting for the majority of the total percolation. The remainder of the effluent is disposed of by evaporation (0.5 mgd) and direct discharge to the Clark Fork River during spring runoff (5.0 mgd).

GENERAL HYDROGEOLOGY

The general hydrogeology of the valley has been described by McMurtrey, Konizeski and Brietkrietz (45). The HW plant is in part of the flood plain of the Clark Fork River, and numerous channels of the river are present on the property.

The entire area is quite variable in its geologic character. At the site of the HW new production well field (about 1-1½ miles south of the plant) a number of holes were drilled during construction of the well field. Based on these drilled holes the entire area near the new production well field generally consists of 25 to 35 feet of sand, silt, and gravel in layers and lenses. Beneath this is 65 to 75 feet of fine sand, silt, clay with scattered gravel layers. This is underlain by a sand and gravel layer about 45 feet thick containing some sand and silt.

Logs of five older production wells in the vicinity of the plant (Brietkrietz, 1964) show in descending order, a six to nine foot topsoil layer, a water-bearing



Hoerner Waldorf Well Fields

FIGURE 13

gravel and sand layer about 20 feet thick, a 190 to 125 foot zone of layers, lenses and mixture of sand, silt and clay with some scattered gravel. This zone is underlain by a 15 to 32 foot thick coarse, water-bearing sand and gravel zone.

Logs of numerous wells both north and south of the plant in the valley show similar geological conditions in the unconsolidated alluvium (Brietzkrietz, 1974 and unpublished well logs submitted to the State of Montana). An upper water-bearing sand and gravel layer underlain by a thicker zone of mixtures and consisting of layers of sand, silt, clay and gravel. Beneath this zone is a good water-bearing zone consisting of coarse gravel and sand. The alluvium is derived from reworking of older glacial debris, lake deposits, and older Tertiary sedimentary deposits from the Missoula Valley area. The alluvium is underlain by bedrock consisting of limestone and argillite of Cambrian or Precambrian age.

Groundwater is present in the unconsolidated alluvium along the river valley. The entire thickness of alluvium (about 130 to 170 feet) contains zones that will readily yield water to wells. There are, however, two zones that are widely used as a source of groundwater and almost all wells in the area are completed in one of these two zones.

An upper layer of alluvium (25 to 35 feet deep), typically composed of sand and gravel, is commonly used as a source of groundwater. This zone could be termed an upper aquifer since its presence is reasonably consistent throughout the area and it typically contains moderate to large quantities of water that can be developed with wells. A number of wells in the area obtain water from this zone.

Beneath this upper zone is a relatively thick interval consisting of layers, lenses and mixtures of sand, silt, clay and gravel. A common characteristic of this interval is its poor ability to yield water to wells. Few wells are completed in the interval and yields of these wells are not high. This interval varies in thickness throughout the area, but generally is 60 to 125 feet thick.

Beneath this interval is an excellent water-bearing zone composed of a coarse sand and gravel with scattered lenses of silt and clay. This lower zone is a prolific water producer and almost all high capacity wells in the area are completed in this zone including all of the HW production wells. Based on numerous wells logs, this lower aquifer or zone is present beneath most of the river valley. The zone is consistently encountered in deep wells in the area. Thickness of this aquifer varies from about 20 to 40 feet.

Hydraulically, the upper and lower aquifers appear to be poorly, but definitely connected. Hydraulic testing on HW wells has indicated the lower aquifer obtains water from the overlying zone and slightly affects water levels in the upper aquifer. This is not an uncommon hydraulic situation and the mechanism of water transfer from a zone layer to a lower zone is termed "leakage." Observation wells near HW production wells also show a poor vertical hydraulic connection in the area. Water levels in deep observation wells respond rapidly to pumpage from the deep aquifer, but shallow observation wells do not show a response to pumpage. Available geological and hydraulic data all indicate that there is an upper aquifer separated from a lower aquifer by a less permeable interval. Another factor of importance in area is the difference in vertical and horizontal permeability. Generally, in horizontally stratified alluvium, lateral permeability is significantly greater than vertical permeability. Typically, the difference in permeabilities are 5 to 100; that is, horizontal permeability is 5 to 100 times greater than vertical.

Recharge to groundwater in the area is from streams, irrigation and precipitation. The areas of recharge are poorly known. The shallow or upper aquifer probably is recharged primarily by irrigation and precipitation and probably discharges to the Clark Fork River. The lower aquifer recharge mechanism is more obscure. Recharge probably comes from streams and irrigation and downward movement from other aquifers. Recharge may occur at some distance from the HW property. Discharge from the lower aquifer is also poorly known. The aquifer probably discharges to the Clark Fork River at some distance downstream from the HW-Frenchtown area.

The general movement of groundwater in the area is toward the Clark Fork River (45). Pumping from well fields has altered groundwater flows by formation of cones or troughs in the water table surface. This actually is not a water table but is a piezometric surface associated with a semi-confined aquifer, but for this report will be termed a water table surface for ease of understanding. The drawdown cones or troughs cause groundwater flow into pumping well fields from surrounding areas. The shape of this surface as drawn by Konizeski is shown in Figure 13.

GROUNDWATER IMPACT

The proposed plant expansion will affect groundwater in four ways.

1. Increased pumpage of water from the deep aquifer for increased plant water requirements.
2. Increased volume of liquid effluent that will be disposed of into the groundwater system.
3. Alteration of groundwater flow patterns due to significant changes in the disposal techniques.
4. Change in quality of water disposed of into the groundwater system.

WATER SUPPLY

Water supply requirements are described by HW as follows:

> The present mill uses 17.3 million gallons of water per day from deep wells in the vicinity of the plant. Five wells are located at the plant site and produce 1/3 of the water requirements.

The remaining water comes from four wells two miles south and upstream from the plant.

With the expansion, water requirements will increase to 28.8 million gallons per day, when the maximum quantity of bleached pulp is manufactured. Three new wells will be drilled. HW has received assurance from a competent hydrologist that this increased supply can be obtained without any adverse effect on the producing aquifers (46).

The hydrologic impact of three new production wells was not determined by HW. The hydrologic consultant stated that "it would be very difficult to predict the contours of the expanded well field, but it is reasonable to expect that the additional influence will be confined to the localized area around the well field."

The three additional wells will be drilled in the vicinity of the new well field (Figure 13). The impact of these wells depends on their exact location and proposed pumping schedule. Based on aquifer characteristics, the impact of such wells on the groundwater system could be estimated. These additional wells will further decrease the hydrostatic head in the deep aquifer. The aquifer is recharged by overlying and nearby groundwater; thus, the impact of an increase in pumpage of 11.5 mgd (66 percent) from this deep aquifer probably would cause changes in hydrostatic pressures within or outside the HW property. The magnitude of water level changes probably would range from a few inches to several feet and is dependent on locations of new wells and pumping schedules on all wells in the water system. The impact of additional pumping will decline rapidly with distance from the pumped wells.

EFFLUENT DISPOSAL

Both the disposal technique and the volume of effluent will significantly change with the proposed plant expansion. As indicated earlier the major volume of wastewater is disposed by seepage to the groundwater, which in turn reaches the river. The ponding system has been expanded as seepage rates have declined in the older ponds.

Meeting the 5 color unit standard with rapid infiltration is a feasible approach on the basis of color data developed in the river during the summer of 1973. Figure 14 shows that the river color only exceeded the 5 color units during a short period in the middle of August. THe river flows during this period were in the range of 1200 to 1400 cfs. Since the Clark Fork River was the lowest that anyone could ever remember, we decided to verify the 10-year, 7-day low flow of 830 cfs as reported by the U.S.G.S.

Figure 15 shows the 7-day low flows for the period from 1939 through 1972. Since the 7-day low flows increased significantly in the early forties and remained stable for the past 30 years, HW made a request to use the last 30 years of data for determining the 10-year, 7-day low flows. However, this request was denied.

We have plotted the 7-day low flows for the period from 1930 through 1972 on probability paper (Figure 16) and found the 90% probability level corresponds to a 10-year, 7-day low flow of 930 cfs. The 7-day low flow for 1973 should raise the 930 cfs figures a little more, and this will be recalculated as soon as the data becomes available.

Assuming that the rate of percolation from our ponds during August, 1973 was equivalent to two-thirds of our present effluent flow, the total amount of color leaving the ponds was equal to:

$$15.8 \times 10^6 \text{ gal/day} \times 2/3 \times 3000 \text{ mg/color/liter} \times 3.785 \text{ liter/gal} \times \text{gm}/10^3 \text{ mg} \times \frac{\text{lb}}{454 \text{ gm}} = 2.64 \times 10^5 \text{ lbs color/day}$$

The 2.64×10^5 lbs color/day is not representative of the color reaching the river, because we have measured a reduction of approximately 40% by the time it reaches our test wells, which are located between the ponds and the river.

Using the data from the summer of 1973, the amount of color required to raise the river color by 6 S.C.U. at a flow of 1200 cfs is calculated as follows:

$$1200 \text{ ft}^3/\text{sec} \times 60 \text{ sec/min} \times 1440 \text{ min/day} \times 7.48 \text{ gal/ft} \times 6 \text{ mg/liter} \times 8.34 \times 10^{-6} \text{ lb-liter/mg-gal} = 39{,}000 \text{ lbs color/day}$$

Therefore, the measured color in the river only represents about 15% of the calculated color leaving the storage ponds.

Under MPDES regulations (MAC 16-2.14(10)-S14460), Section (2), the minimum effluent standards are the same as those adopted by EPA.

FIGURE 14

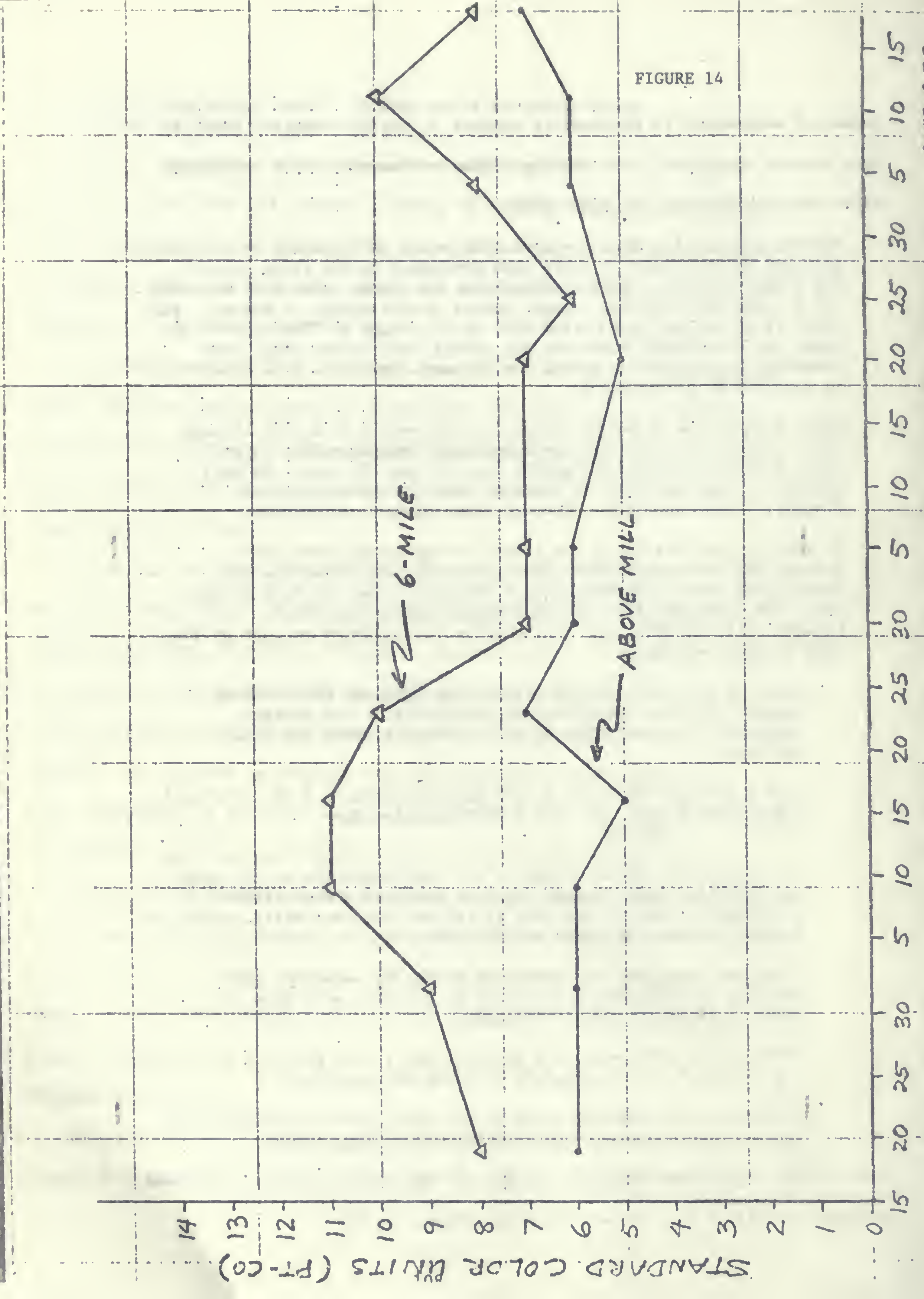
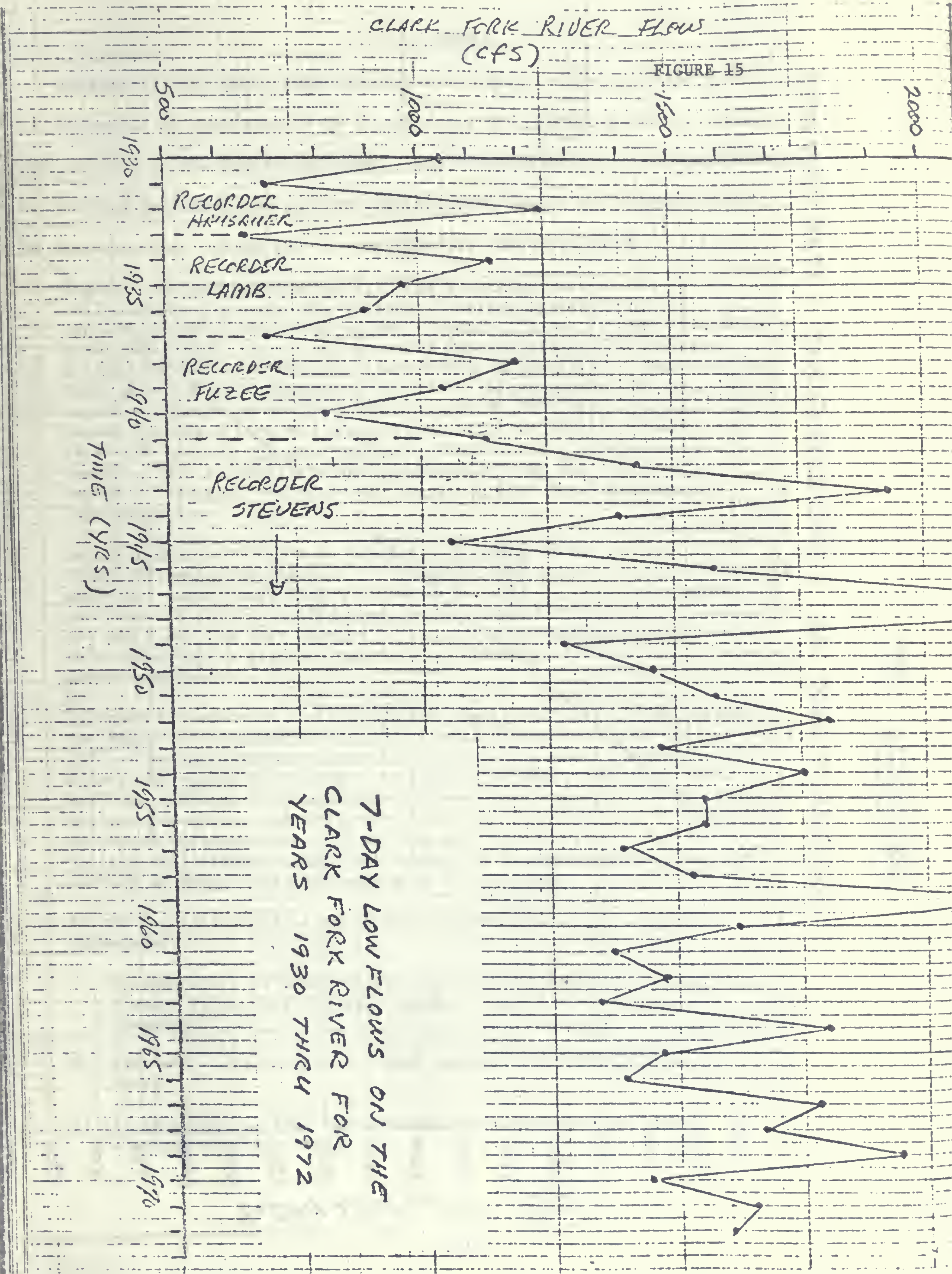
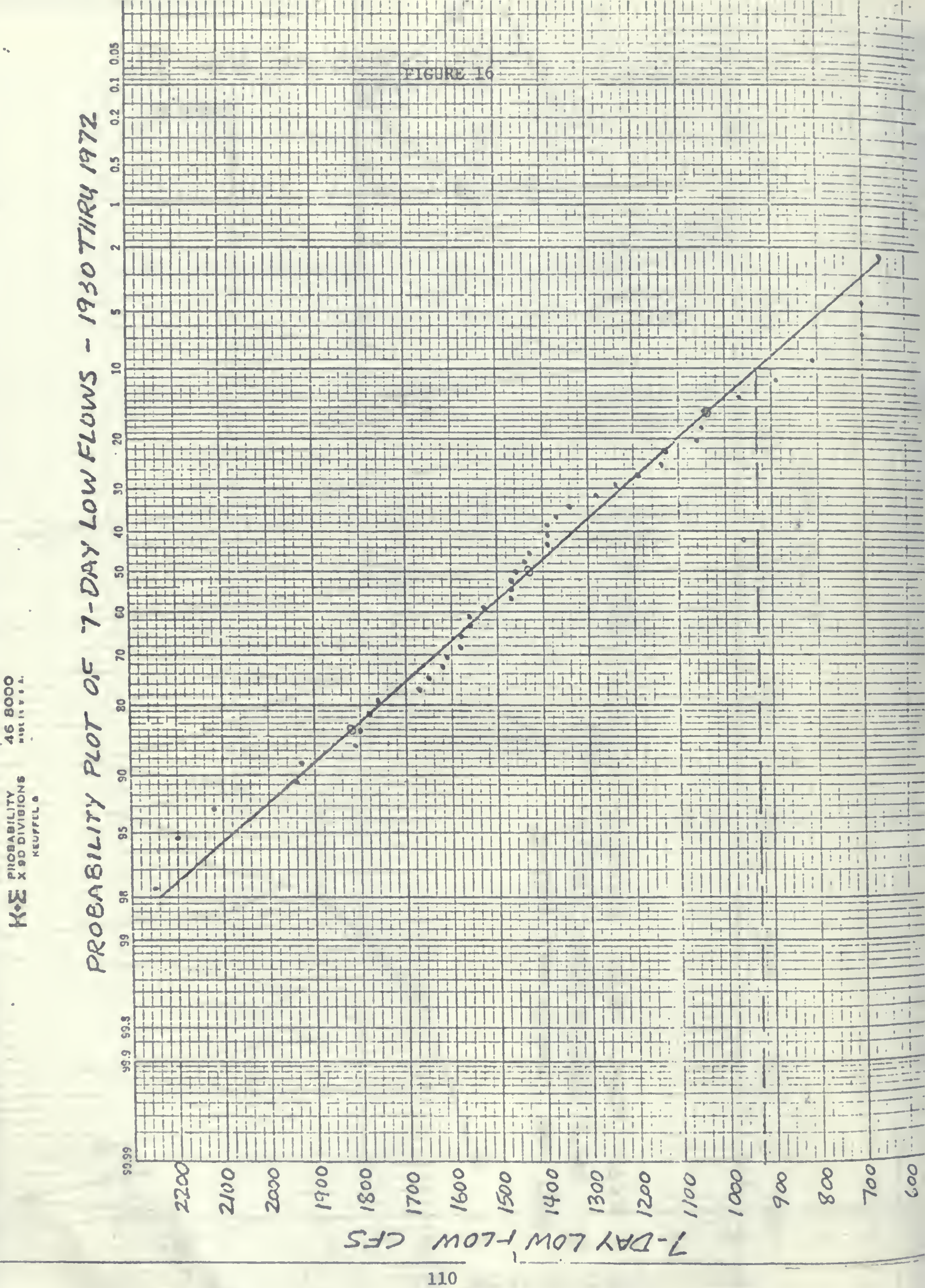

STANDARD COLOR UNITS (PT-CO)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
20
25
30
5
10
15
20
25
30
5
10
15
20
25
30
5
10
15
6-MILE
ABOVE MILL

FIGURE 15



7-DAY LOW FLOWS ON THE CLARK FORK RIVER FOR YEARS 1930 THRU 1972

FIGURE 16



PROBABILITY PLOT OF 7-DAY LOW FLOWS - 1930 THRU 1972

HW recently has begun experimenting with rapid infiltration basins, which, if successful as predicted by HW consultants, will permit ground disposal of the majority of the treated effluent. The proposed infiltration system would be utilized following the aerated stabilization basins and settling ponds. HW describes this system and the experimental work being done as follows:

> Briefly, reduced percolation from the existing ponds is due to the soil sealing at or near the surface. Sealing is caused by the surface growth of bacterial slimes, coagulation and flocculation of dissolved organic matter and possibly by the formation of ferrous sulfide in the soil. Because these bacteria generate ferrous sulfide, their presence is indicated by localized concentrations of iron and organics. Analysis of the pond bottom at HW indicates a higher than normal localized iron and organic concentration exists between 0 and 16 inches beneath the soil surface. Similar tests conducted in conjunction with permeability studies indicate that the greatest degree of plugging occurs in the region of high iron and organic concentrations.
>
> As explained, a solution to anaerobic plugging is to rapidly infiltrate effluent into the soil to the point just prior to establishing anaerobic conditions. Then, allowing the soil to dry, will induce oxidation of ferrous sulfide and aerobic breakdown by any organics to CO_2 and H_2O. The installation of secondary treatment will also help this situation by greatly reducing the tendency of the effluent to become anaerobic.
>
> In order to determine the appropriate dosing and drying time periods, two rapid infiltration basins were constructed in the late fall of 1973. The first basin constructed contained an actual area of 4.15 acres, the second 7.33 acres. As of mid-February, the first basin had been operated through seven cycles of approximately 6.9 million gallons per cycle, and the second basin had been operated through five cycles of approximately 10.0 million gallons per cycle. Dr. Al Wallace will prepare a detailed summary of results to date, for submission as supporting information on this system.
>
> If rapid infiltration is successful, it would have the following advantages:
>
> 1. Economically, it would be the best method, because it utilizes present structures and will require a minimum of additional resources.
>
> 2. Test well data indicates a high degree of BOD removal via this route.
>
> 3. It is projected that the expanded mill will meet the color standard via this route.

4. Because of the nature of underground water flows, no localized high concentrations of effluent result, as would be the case at the end of a discharge pipe.

The infiltration test basins and associated water quality monitoring wells are shown in Figure 3 . The test well and water quality sampling program is being conducted by HW as part of a cooperative study between HW and the University of Montana. Some of the older, tightly sealed ponds south and west of the plant will be redeveloped for use as rapid infiltration areas. If rapid infiltration proves successful as a long-term disposal strategy, it is expected that there will be flexibility in the choice of areas to be utilized for disposal; thus, some control can be exerted on groundwater flow patterns.

There have been no substantiated cases of groundwater quality or water table elevation changes peripheral to the HW property due to present disposal practices.

One case of well contamination was reported about ½ mile southeast of the HW plant. Investigation of the complaint by the SDHES revealed smelly, poor quality groundwater in a shallow well. It was also determined that there were two cesspools very near the bad well. Inorganic tests indicate an increase of dissolved mineral content as compared to nearby wells. However, the constituents that increased are common both to domestic wastes (cesspools) and to kraft wastes. Organic testing revealed no organic compounds typical of kraft wastes. The smell of water from the well decreased with time but the cause of the problem was not determined.

A second case of possible well pollution was mentioned at the environmental impact hearing at Missoula--the Kona Ranch to the east of the mill (shown as private well 8 on Figure 3). Analysis of this well water was not shown on Table 26as it was not completed at the time the draft statement was written. It is now shown on Table 26 Because it was reported that cattle would not drink

TABLE 26 . TYPICAL CHEMICAL QUALITY OF GROUNDWATER IN WELLS ON AND NEAR THE HOERNER-WALDORF PROPERTY

Water Analyses by the Montana Department of Health and Environmental Sciences

All units in milligrams per liter except where shown otherwise.

Sampling Station	Date Sampled	Temperature (°C)	pH (S.U.)	Dissolved Calcium (Ca)	Dissolved Magnesium (Mg)	Dissolved Sodium (Na)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Specific Conductance (uhmo/cm at 25°C)	Color (CU)	Reported Depth (Ft.)
Pvt. Well 1	2-14-74	10.6	8.10	48	15	12	218	28	2.5	2.78	396	<5	162
Pvt. Well 2	2-14-74	9.4	7.81	75	25	25	249	89	4.5		648	<5	50
Pvt. Well 3	4-3-74	6.0				18		59	7.7	5.89	441	<5	40
Pvt. Well 4	4-3-74	10.0				18		41	1.9		399	<5	unknown
Pvt. Well 5	4-3-74	10.4				21		57	15.4		698	<5	unknown
Composite H-W new well field	4-17-74		7.80	51	17.7	13.5	224	37	2.0	1.1	424		
School Well	4-4-74	10				3.2		12	0.1		237	<5	200
Pvt. Well 6	5-6-74					15						<5	unknown
Pvt. Well 7	5-6-74					10						<5	157
Pvt. Well 9	5-6-74					25						<5	48
Pvt. Well 8	6-10-74		7.80	35	13.7	18	181	30	2.0		340	<5	20
Pvt. Well 10	4-4-74	6.5				19		49	1.2		549	<5	unknown
Pvt. Well 11*	4-4-74	8.2				84		32	0.2		370	<5	45
Pvt. Well 12	5-6-74					4.8						<5	42
Pond 13	4-3-74	8.6	8.40			530					2295		
Test Well 5	2-14-74	8.6	7.96	31	10.2	170	411	43	73	1.50	926		

*Sample taken after softening.

this water, a phenol analysis was also performed on this water. THe test was negative for phenols. The chemical analyses performed do not indicate anything unusual about this well. However, it is reported that surface water can enter this well. It was mentioned at the hearing that the total organic carbon was extremely high (10 milligrams per liter) on the Kona well, indicating pollution. On the chemical analysis sheet the WQB sent to the University of Montana, it was noted that the 10 mg figure was not correct because of equipment malfunction. The WQB's TOC instrument was new and had many operational problems when it was utilized on the well water samples. It was not performing accurately at the time so the TOC results were not placed in the EIS.

Existing groundwater flow patterns of pond effluent therefore appear to be relatively restricted. There are only a few private wells near the HW area, and the HW monitoring and test well net is not extensive, so the areal extent of groundwater influenced by seepage of wastes is not clearly defined.

A general groundwater flow direction toward the river presently exists in the upper aquifer. An anticipated effluent volume of 21.6 mgd and a possible 100 percent percolation disposal results in a potential total disposal of 21.6 mgd to the shallow groundwater system or an increase of 112 percnet from the present ground disposal of 10.2 mgd. The impact of this added volume on existing groundwater flow pattern cannot be predicted from the available data. Of principal concern will be the required horizontal area needed to move 21.6 mgd through the shallow groundwater system. There also is definite evidence of vertical movement of waste effluent from the upper shallow aquifer into the deep aquifer in the plant area. Movement of dissolved chemicals from waste ponds into plant production wells tapping the deep aquifer has been detected. This interaquifer movement has been accentuated by drawdown in the old plant production wells. This problem may be confined to the drawdown cone created by pumpage of production wells in the plant area. No chemical contamination has been noticed in deep wells peripheral to the HW property.

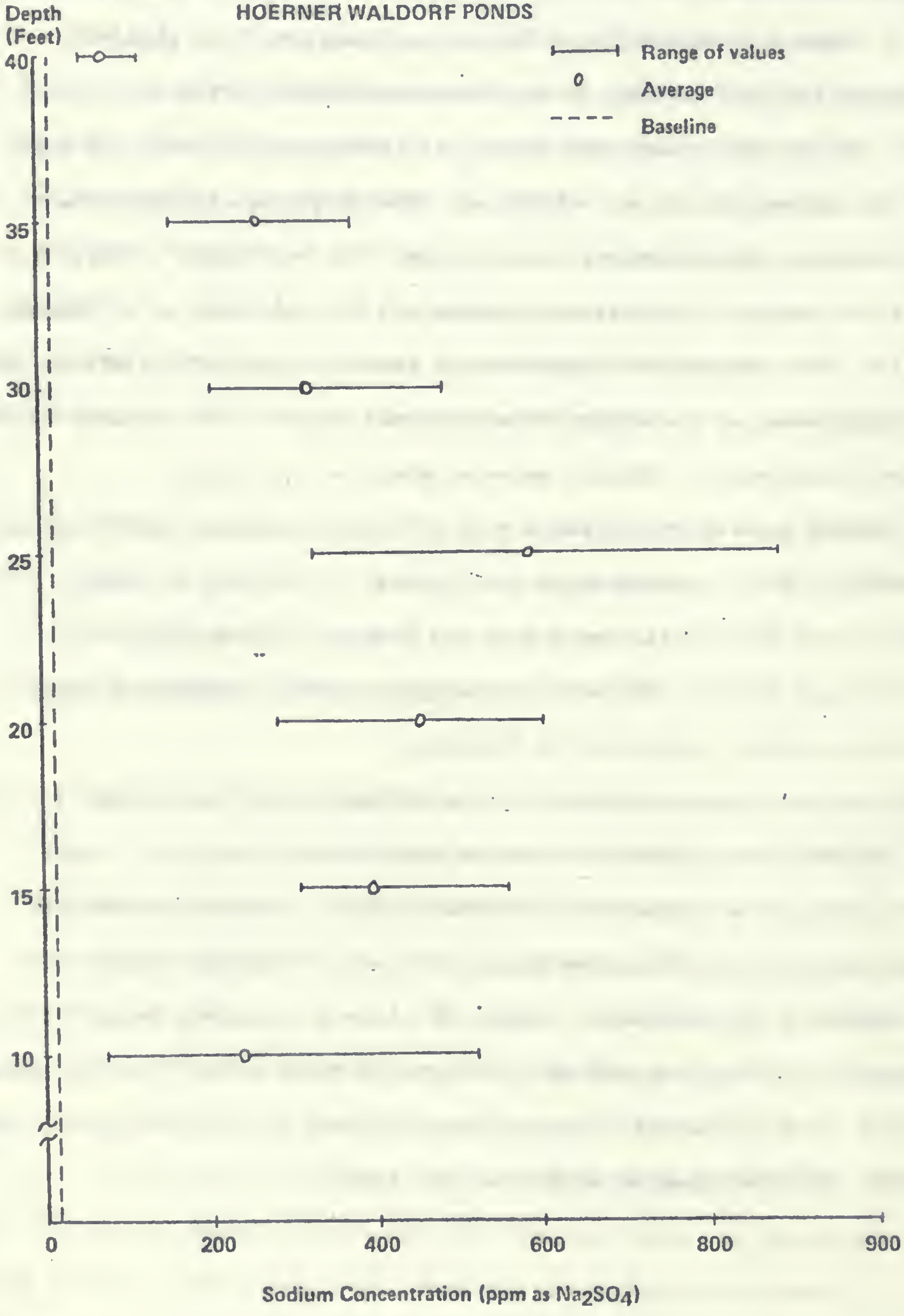
Since aquifer exploration and testing is limited in the area, the deep movement of wastewaters is not well known. The long-range implications of vertical movement of wastewaters is not known. The preference of water for horizontal movement in the layered alluvium and the existence of a drawdown cone in the plant area should significantly reduce or possibly eliminate any widespread movement of wastewater into the lower aquifer. If the deep aquifer did become contaminated, remedial measures would be very costly.

The shallow aquifer system has a good ability to transmit water and has, for a number of years, accommodated the disposal of 10.2 mgd of wastes. Preliminary test infiltration pond data and general considerations of this practice at HW (A.T. Wallace private report to HW) indicates a rapid infiltration disposal system may be feasible.

Dissolved constituents abundant in the effluent ponds are present in a diluted concentration in production wells located near the plant. These wells are known to be completed in the deep aquifer. Downstream from the HW ponds, water quality data from recent test wells indicates limited vertical movement of mill effluent. Figure 17 (from a consultant report to HW) illustrates the decrease in sodium with depth in these wells. This decrease is reported to by typical of 11 wells tested to date in the north part of the HW property (HW communication of October 15, 1974).

FIGURE 17

CHANGE IN SODIUM CONCENTRATION WITH DEPTH OF TEST WELLS DOWNSTREAM FROM HOERNER WALDORF PONDS



QUALITY CHANGES IN THE GROUNDWATER SYSTEM

Wells to measure the direction of groundwater movement and changes in composition of percolated wastewater have been present since 1968, and several wells in the area are used as domestic supplies. Typical water quality data from the area are shown in Table 26 . Specific conductance, sodium and color are key parameters in the study of infiltration of Kraft wastes. Additional testing for both organic and inorganic constituents is planned for wells near the HW property. Total organic carbon in particular should have good application in testing for pollution of water well systems. A summary of a portion of the data obtained by HW to determine quality changes in the groundwater during 1973 is shown in Table 27. Data are available for a number of years prior to 1973 and an analysis of these shows results similar to 1973 data. The 1973 data probably best reflect the current disposal system.

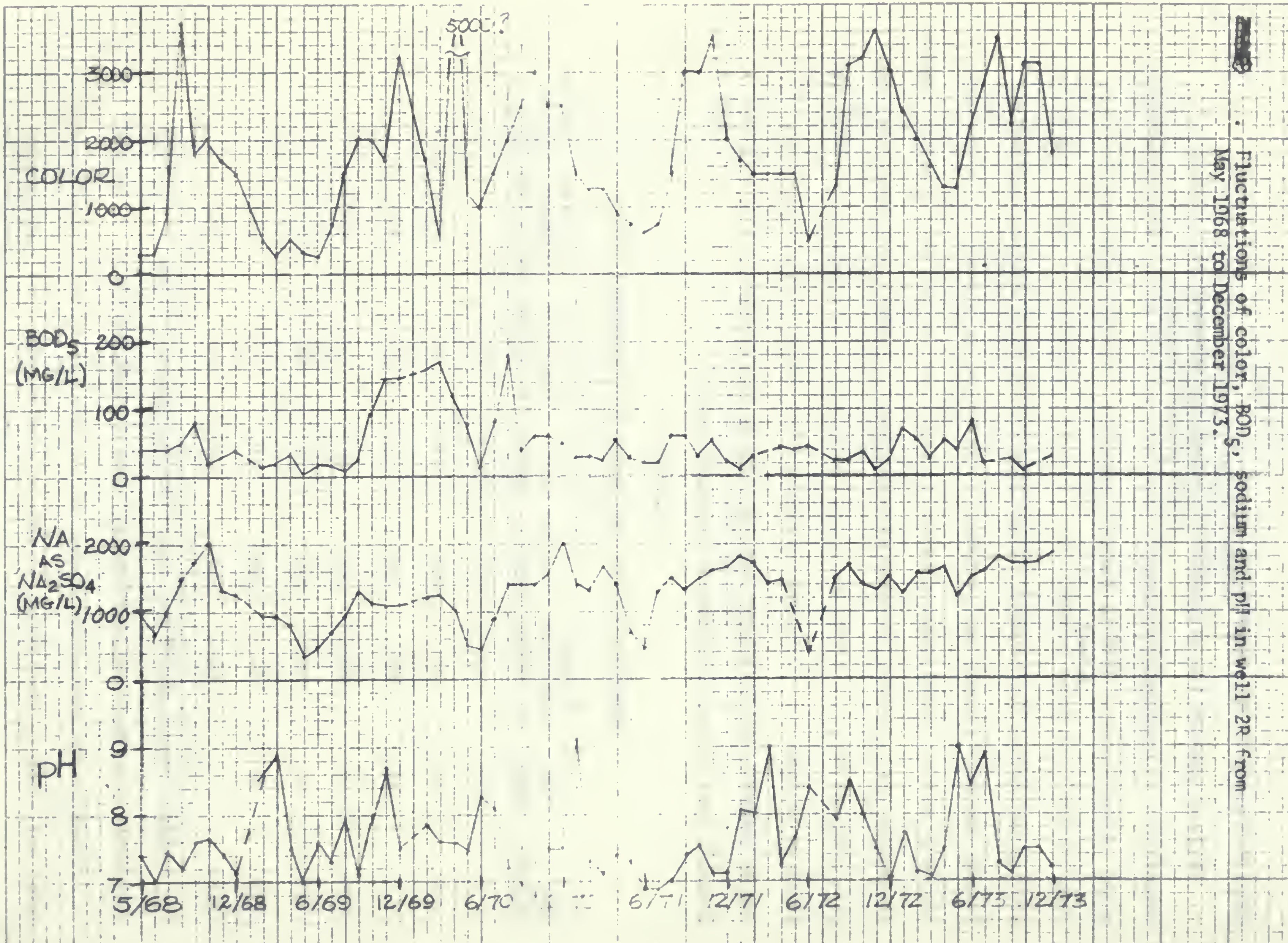
Table 27

REDUCTION IN BOD AND SODIUM IN GROUNDWATER SYSTEM

Test Well No.	BOD mg/l	Percent Reduction in Aquifer	Sodium mg/l	Color Units	Percent Reduction in Aquifer	Elevation of Water in Wells - feet above sea level
2	38	93	522	2050	27	--
4	33	93	450	1476	39	3028.1
5	17	92	228	482	59	3027.2
404	31	83	187	845	12	3035.1
421	14	93	203	547	48	3029.2
423	35	82	206	380	64	3030.9
514	5	96	139	188	73	3027.6

The average removal of BOD and color obtained during the year (Table 27) represents the concentrations from the time it left the plant to the time it arrived in the test well. There are fluctuations in water quality in these wells due to precipitation, rate of pond seepage, and river stage (Figure 18). There are a number of assumptions used in this calculation.

[redacted] . Fluctuations of color, BOD_5, sodium and pH in well 2R from May 1968 to December 1973.



Squares to the Inch

These are:

1. Average pond concentrations of sodium, BOD, and color are constant and are: 558 mg/1, 560 mg/1 and 3000 cu (color units) respectively.
2. Sodium is assumed to be conservative; that is, its concentration is changes only by dilution, and it is not sorbed or desorbed by the soil system.
3. Background sodium in groundwaters unaffected by pond wastes is 12 mg/1.
4. Wastes travel in the upper aquifer and are accurately sampled by the monitoring wells.

None of these assumptions exactly reflects the real system, but they are thought to be reasonable approximations. Average pond values for sodium, BOD, and color are based on the average of each pond for each month during 1973. These values were reasonably consistent during the year. Sodium can be adsorbed by soils and thus may not be conservative. Adsorption would, however, lower the apparent reduction percentage; that is, the actual in-the-ground reduction would be greater than the calculated reduction. After five years of disposal of high sodium wastes, the adsorption capacity of the soil for sodium ions may be exhausted and the assumption that sodium is conservative may be valid. Background sodium values are not well known but appear to be in the range of 8 to 25 mg/1 with 12 mg/1 a reasonable approximation. Color and BOD removal percentages are not very sensitive to error in assumed background sodium in the 8 to 25 mg/1 range. Based on all available data, wastes appear to travel primarily in the upper aquifer.

These calculations provide a rough estimate of removal of color and BOD in the soil. THe mechanism of color removal in the groundwater system at HW is unknown. Possible mechanisms are: (a) sorption or chemical reaction with earth materials or groundwater in the aquifer; (b) chemical or biological alteration of color-producing compounds to non-color producing compounds. Removal of BOD probably involves physical filtration of organic particulates in the aquifer and possible anaerobic biological decomposition in portions of the aquifer.

It can only be speculated at this time that color reduction will continue to be obtained with the aerobic effluent from the proposed aerated stabilization basins and the rapid infiltration system.

SURFACE WATER QUALITY

The Clark Fork River drainage basin upstream from Missoula has an area of about 9,300 square miles and includes the Bitterroot, Blackfoot and the Little Blackfoot River drainages. The river generally is a good quality calcium-bicarbonate type water with low to moderate concentrations of dissolved minerals. Water quality based on data collected by the U.S.G.S. from 1968 to 1971 above and below Missoula is summarized in Tables 28 and 29. The Clark Fork River in the Missoula area is classified by the state of Montana as a B-D_1 stream. Details of the classification are given elsewhere in this report. At times in the past, concentrations of iron, copper, zinc, lead and manganese have been high. This was principally due to wastes from upstream metal processing activities of the Anaconda Company. Recent industrial improvements in the Anaconda Company Butte operations have significantly reduced metal concentrations and future improvements will further reduce metal loads.

A number of investigations recently have been conducted on the Clark Fork River to determine the effects of the HW discharge on water quality. These investigations are:

Date	Investigating Group	Parameters Measured
April-June, 1973	Montana Fish and Game Department (47)	DO, temperature, turbidity, specific conductance
May 30-31, 1973	Water Quality Bureau	DO, BOD, color, temperature
1973 (discharge season) May-June	HW Corporation (48)	DO
1973 (discharge season) May-June	Ecological Consulting Ser.	DO, aquatic biology

Table 28.

```
STORET  DATE 74/02/09
                                                   293005              12340500
                                                  46 52 00.0 113 59 00.0  2
                                                  CLARK FORK ABOVE MISSOULA
                                                  30     MONTANA
                                                  PACIFIC NORTHWEST
                                                  CLARK FORK PEND OREILLE RIVER BASIN
                                                  11190050              02111204
                                                   0000
INDEX 1310001   007520
MILES 0749.50 0358.30
PARAMETER                                   NUMBER    MEAN   VARIANCE STAN DEV CCEF VAR STAND ER MAXIMUM   MINIMUM  BEG DATE END DATE
00010  WATER      TEMP      CENT              26   9.36154  31.3993  5.60351  .598567  1.09894  18.0000  .500000 68/04/16 71/05/04
00070   TURB      JKSN      JTU               14   5.85714  60.9011  7.80392  1.33238  2.08568  24.0000  1.00000 68/04/16 69/07/08
00080  COLOR      PT-CO     UNITS             14   9.92857  54.6868  7.39505  .744826  1.97641  25.0000  4.00000 68/04/16 69/07/08
00095 CNDUCTVY    AT 25C    MICROMHO          14   363.928  9054.69  95.1561  .261469  25.4315  500.000  210.000 68/04/16 69/07/08
00300    DO                 MG/L              14   10.2179  1.46065  1.20858  .118281  .323005  12.2000  8.40000 68/04/16 69/07/08
00301    DO       SATUR     PERCENT           12   100.000  17.8182  4.22116  .042212  1.21854  108.000  95.0000 68/07/24 69/07/08
00400    PH                 SU                14   8.09285  .211501  .459892  .056827  .122911  8.50000  6.80000 68/04/16 69/07/08
00410  T ALK      CACO3     MG/L              13   105.538  647.609  25.4482  .241127  7.05805  147.000  71.0000 68/04/16 69/07/08
00425 HCO3 ALK    CACO3     MG/L              13   101.538  453.943  21.3059  .209831  5.90920  136.000  71.0000 68/04/16 69/07/08
00430 CO3 ALK     CACO3     MG/L               4   26.2500  186.250  13.6473  .519899  6.82367  41.0000  9.00000 68/08/20 68/10/28
00610  NH3-N      TOTAL     MG/L              14   .031429  .001148  .033879  1.07797  .009055  .100000  .005000 68/04/16 69/07/08
00615  NO2-N      TOTAL     MG/L              14   .009714  .000143  .011945  1.22963  .003192  .050000  .001000 68/04/16 69/07/08
00620  NO3-N      TOTAL     MG/L              14   .069857  .005707  .075545  1.08142  .020190  .260000  .005000 68/04/16 69/07/08
00625 TOT KJEL    N         MG/L              14   .380714  .019577  .139917  .367511  .037394  .700000  .100000 68/04/16 69/07/08
00665 PHOS-TOT              MG/L P            14   .048000  .000938  .030624  .638006  .008185  .110000  .024000 68/04/16 69/07/08
00671 PHOS-DIS    ORTHO     MG/L P             4   .013000  .000008  .002828  .217572  .001414  .017000  .011000 69/04/23 69/07/08
00680 T ORG C     C         MG/L              12   1.85000  1.47000  1.21244  .655371  .350000  4.00000  1.00000 68/05/07 69/07/08
00681 D ORG C     C         MG/L               1   2.00000                                      2.00000  2.00000 68/05/07 68/05/07
00690 T-CARBON    C         MG/L               4   22.5000  33.6667  5.80230  .257880  2.90115  30.0000  17.0000 69/04/23 69/07/08
00720 CYANIDE     CN-TOT    MG/L               1   .020000                                      .020000  .020000 68/04/16 68/04/16
00900 TOT HARD    CACO3     MG/L              14   193.714  7532.53  86.7902  .448032  23.1956  408.000  89.0000 68/04/16 69/07/08
00910 CALCIUM     CACO3     MG/L              12   116.333  4105.52  64.0743  .550782  18.4967  257.000  15.0000 68/04/16 69/07/08
00930  SODIUM     NA,DISS   MG/L              13   6.52307  4.74526  2.17836  .333947  .604169  9.70000  2.50000 68/04/16 69/07/08
00935 PTSSIUM     K,DISS    MG/L              13   2.08461  .289349  .537911  .258039  .149190  2.90000  1.20000 68/04/16 69/07/08
00940 CHLORIDE    CL        MG/L              14   2.71428  .835171  .913877  .336692  .244244  4.00000  1.00000 68/04/16 69/07/08
00945 SULFATE     SO4-TOT   MG/L              13   52.6923  681.232  26.1004  .495336  7.23895  120.000  19.0000 68/04/16 69/07/08
00956  SILICA     TOTAL     MG/L              11   12.3545  5.48877  2.34281  .189632  .706385  18.3000  9.50000 68/04/16 69/07/08
01000 ARSENIC     AS,DISS   UG/L               1   5.00000                                      5.00000  5.00000 68/04/16 68/04/16
01040 COPPER      CU,DISS   UG/L              14   57.0414  18746.0  136.916  2.40029  36.5924  530.000  6.30000 68/04/16 69/07/08
01045   IRON      FE,TOT    UG/L               6   734.166   284835  533.700  .726946  217.882  1500.00  154.000 68/10/28 69/07/08
01049   LEAD      PB,DISS   UG/L              14   38.3500  1496.00  38.6781  1.00856  10.3372  133.000  9.10000 68/04/16 69/07/08
01090   ZINC      ZN,DISS   UG/L              14   147.100  31599.5  177.763  1.20845  47.5090  640.000  31.1000 68/04/16 69/07/08
31503 TOT COLI    MFIMENDO  /100ML            14   1086.07  2454777  1566.77  1.44260  418.738  5200.00  25.0000 68/04/16 69/07/08
39330  ALDRIN     WHL SMPL  UG/L              12   .001000 .289E-11  .000002  .001701  .000000  .001000  .001000 70/05/13 71/05/04
39340   BHC       WHL SMPL  UG/L              12   .001000 .289E-11  .000002  .001701  .000000  .001000  .001000 70/05/13 71/05/04
39360   DDD       WHL SMPL  UG/L              12   .001250  .000000  .000452  .361817  .000131  .002000  .001000 70/05/13 71/05/04
39365   DDE       WHL SMPL  UG/L              12   .001000 .289E-11  .000002  .001701  .000000  .001000  .001000 70/05/13 71/05/04
39370   DDT       WHL SMPL  UG/L              12   .003500  .000003  .001624  .463912  .000469  .007000  .002000 70/05/13 71/05/04
39380 DIELDRIN    WHL SMPL  UG/L              12   .001417  .000001  .000900  .635533  .000260  .004000  .001000 70/05/13 71/05/04
```

Table 28 (Cont.)

```
STORET DATE 74/02/09
:
                                                      293005              12340500
                                                      40 52 00.0 113 59 00.0  2
                                                      CLARK FORK ABOVE MISSOULA
                                                      30     MONTANA
                                                      PACIFIC NORTHWEST
                                                      CLARK FORK PEND OREILLE RIVER BASIN
                                                      11150050            02111204
                                                       0000
INDEX 1310001  007520
MILES 0745.50 0358.30
PARAMETER                            NUMBER   MEAN   VARIANCE STAN DEV COEF VAR STAND ER MAXIMUM  MINIMUM  BEG DATE END DATE
39390  ENDRIN    WHL SMPL   UG/L         12 .001917  .000007  .002610  1.36159  .000753  .010000  .001000 70/05/13 71/05/04
39410  HCHLR     WHL SMPL   UG/L         12 .001000 .289E-11  .000002  .001701  .000000  .001000  .001000 70/05/13 71/05/04
39420 HCHLR-EP   WHL SMPL   UG/L         12 .001000 .289E-11  .000002  .001701  .000000  .001000  .001000 70/05/13 71/05/04
70507  PHOS-1     ORTHO    MG/L P        14 .013071  .000132  .011479  .878164  .003068  .052000  .008000 68/04/16 69/07/08
```

TAble 28 (Cont.)

```
STORET DATE 74/02/05
                                                               12340500
                                                              46 52 00.0 113 59 00.0  2
                                                              CLARK FORK ABOVE MISSOULA
                                                              30    MONTANA
                                                              PACIFIC NORTHWEST
                                                              CLARK FORK PEND OREILLE RIVER BASIN
                                                              112WRD                  02111204
                                                               0000
DEX 1310001  007520
LES 0745.50 0358.30
RAMETER                                          NUMBER   MEAN   VARIANCE  STAN DEV  COEF VAR  STAND ER  MAXIMUM   MINIMUM  BEG DATE END DATE
000 ARSENIC    AS,DISS       UG/L                  18  3.00000   5.29412   2.30089   .766965   .542226   7.00000   .000000 68/04/16 71/04/07
005  BARIUM    BA,DISS       UG/L                  16  .000000   .000000   .000000             .000000   .000000   .000000 69/07/10 71/01/08
010 BERYLIUM   BE,DISS       UG/L                   5  .000000   .000000   .000000             .000000   .000000   .000000 70/03/18 71/04/07
020  BORON      B,DISS       UG/L                  24  18.5792   285.650   16.9012   .909686   3.44994   66.0000   .000000 69/07/10 71/06/02
025 CADMIUM     CD,DISS      UG/L                  17  .011765   .002353   .048507   4.12310   .011765   .200000   .000000 69/07/10 71/04/07
030 CHROMIUM   CR,DISS       UG/L                  17  .000000   .000000   .000000             .000000   .000000   .000000 69/07/10 71/04/07
035 COBALT     CO,DISS       UG/L                  17  .177059   .154197   .392679   2.21779   .095239   1.00000   .000000 69/07/10 71/04/07
040 COPPER     CU,DISS       UG/L                  36  26.5997   7627.71   87.3368   3.28337   14.5561   530.000   .000000 68/04/16 71/06/02
042 COPPER     CU,TOT        UG/L                   5  94.0000   20430.0   142.934   1.52057   63.9218   340.000   10.0000 70/10/07 71/06/02
045    IRON    FE,TOT        UG/L                  10  807.500   1552566   1246.02   1.54306   394.026   4200.00   50.0000 68/10/28 71/06/02
046    IRON    FE,DISS       UG/L                  23  32.1578   1262.53   35.8124   1.11365   7.46740   140.000   .000000 69/07/10 71/06/02
049    LEAD    PB,DISS       UG/L                  27  14.0786   896.899   29.9483   2.12721   4.92346   133.000   .000000 68/04/16 71/06/02
051 LEAD       PB,TOT        UG/L                   5  19.6000   657.800   26.4159   1.34775   11.8136   66.0000   1.00000 70/10/07 71/06/02
055 MANGNESE      MN         UG/L                   7  142.714   25091.6   158.403   1.10993   59.8708   450.000   39.0000 69/07/10 71/06/02
056 MANGNESE   MN,DISS       UG/L                  19  44.2631   1587.32   39.8411   .900097   9.14018   152.000   .000000 69/10/16 71/06/02
060   MOLY     MO,DISS       UG/L                  17  4.11765   18.7353   4.22843   1.05119   1.04980   13.0000   .000000 69/07/10 71/04/07
065  NICKEL    NI,DISS       UG/L                  17  1.94176   13.1814   3.63062   1.86975   .880555   15.0000   .000000 69/07/10 71/04/07
075  SILVER    AG,DISS       UG/L                  17  .118235   .110153   .331893   2.80706   .080496   1.00000   .000000 69/07/10 71/04/07
080 STRONTUM   SR,DISS       UG/L                  22  290.045   7018.62   83.7772   .288842   17.8613   388.000   105.000 69/07/10 71/06/02
082 STRONTUM   SR,TOT        UG/L                   5  176.000   6880.00   82.9458   .471283   37.0945   270.000   60.0000 70/10/07 71/06/02
085 VANADIUM    V,DISS       UG/L                  18  .633333   .251765   .501762   .792256   .118266   2.00000   .000000 69/07/10 71/04/07
090    ZINC    ZN,DISS       UG/L                  35  52.5543   6434.15   80.2132   1.52629   13.5585   360.000   .000000 68/04/16 71/06/02
092 ZINC       ZN,TOT        UG/L                   5  162.000   51570.0   227.090   1.40179   101.558   540.000   10.0000 70/10/07 71/06/02
105 ALUMINUM    AL,TOT       UG/L                   5  100.000   5000.00   70.7107   .707107   31.6228   200.000   .000000 69/07/10 69/09/18
106 ALUMINUM    AL,DISS      UG/L                  12  85.4167   2592.82   50.9197   .596133   14.6993   192.000   30.0000 69/10/16 70/10/07
145 SELENIUM   SE,DISS       UG/L                  17  3.94118   13.8388   3.72006   .943895   .902246   13.0000   .000000 69/07/10 71/04/07
501 TOT COLI   MFIMENDO     /100ML                 22  402.682    887158   941.891   2.23904   200.812   3800.00   4.00000 69/07/10 71/06/03
503 TOT COLI   MFDLENDO     /100ML                 14  1086.07   2454777   1566.77   1.44260   418.738   5200.00   25.0000 68/04/16 69/07/08
616 FEC COLI   MFM-FCBR     /100ML                 19  77.1053   14226.7   119.276   1.54692   27.3627   430.000   .000000 69/10/16 71/06/03
300 RESIDUE    DISS-180   C     MG/L               16  275.375   11900.0   109.087   .396140   27.2718   398.000   .009872 69/07/10 71/04/07
302 DISS SOL   TONS/DAY                            18  2108.61   1476199   1214.99   .576204   286.375   4830.00   794.000 69/07/10 71/04/07
303 DISS SOL   TONS PER    ACRE-FT                 16  .373125   .021836   .147771   .396035   .036943   .540000   .000000 69/07/10 71/04/07
507  PHOS-T     ORTHO       MG/L P                 22  .015454   .000199   .014111   .913061   .003008   .052000   .000000 68/04/16 71/06/02
845 AMMONIA    TOT-NH4       MG/L                   4  .029999   .002200   .046904   1.56351   .023452   .100000   .000000 71/02/02 71/06/02
850 NITRATE    TOT-NO3       MG/L                  17  .382353   .135294   .367823   .962000   .089210   1.30000   .000000 69/07/10 70/12/02
855 NITRITE    TOT-NO2       MG/L                  15  .016667   .000181   .013452   .807117   .003473   .050000   .000000 69/07/10 71/04/07
890 MERCURY    HG,DISS       UG/L                  11  .156363   .068126   .261009   1.66925   .078697   .900000   .000000 70/07/12 71/06/02
900 MERCURY    HG,TOTAL      UG/L                   6  .318333   .124417   .352727   1.10805   .144000   1.00000   .009999 70/11/04 71/06/02
```

Table 28 (Cont.)

```
STORET  DATE 74/02/05
                                                                    12340500
                                                                   46 52 00.0 113 59 00.0  2
                                                                   CLARK FORK ABOVE MISSOULA
                                                                   30     MONTANA
                                                                   PACIFIC NORTHWEST
                                                                   CLARK FORK PEND OREILLE RIVER BASIN
                                                                   112WRD                 02111204
                                                                    0000
INDEX 1310001   007520
MILES 0745.50 0358.30
PARAMETER                                      NUMBER    MEAN    VARIANCE  STAN DEV  COEF VAR  STAND ER  MAXIMUM   MINIMUM  BEG DATE END DATE
00010  WATER       TEMP       CENT                 51  7.72351   39.3146   6.27014   .811783   .877995   18.0000   .000000 68/04/16 71/06/03
00020   AIR        TEMP       CENT                 22  10.5227   82.1066   9.06127   .861114   1.93187   29.0000   .000000 69/07/10 71/06/02
00060  STREAM      FLOW       CFS                  42  3601.19  .147E+08   3845.00   1.06770   593.296   15300.0   1000.00 69/07/10 71/06/02
00070   TURB       JKSN       JTU                  30  8.13333   123.775   11.1254   1.36788   2.03121   55.0000   1.00000 68/04/16 71/01/08
00080  COLOR       PT-CO      UNITS                30  7.96700   53.5451   7.31745   .918470   1.33598   25.0000   .009999 68/04/16 71/04/07
00095 CNDUCTVY     AT 25C     MICROMHO             39  385.333   15880.7   126.019   .327028   20.1791   560.000   .009872 68/04/16 71/06/02
00300    DO                   MG/L                 36  10.6125   2.09241   1.44652   .136304   .241086   13.0000   8.00000 68/04/16 71/06/02
00301    DO        SATUR      PERCENT              12  100.000   17.8182   4.22116   .042212   1.21854   108.000   95.0000 68/07/24 69/07/08
00310   BOD        5 DAY      MG/L                 23  1.28260   .524518   .724236   .564661   .151014   3.20000   .100000 69/07/10 71/06/02
00400    PH                   SU                   39  7.88222   1.79302   1.33904   .169881   .214417   8.50000   .008999 68/04/16 71/06/02
00410  T ALK       CACO3      MG/L                 35  112.666   785.344   28.0240   .248692   4.73692   194.000   69.0000 68/04/16 71/06/02
00425 HCO3 ALK     CACO3      MG/L                 13  100.462   449.276   21.1961   .210988   5.87875   136.000   71.0000 68/04/16 69/07/08
00430 CO3 ALK      CACO3      MG/L                  4  26.2500   186.250   13.6473   .519899   6.82367   41.0000   9.00000 68/08/20 68/10/28
00440 HCO3 ION     HCO3       MG/L                  1  92.0000                                           92.0000   92.0000 71/06/02 71/06/02
00605  ORG N       N          MG/L                 17  .193529   .021199   .145600   .752342   .035313   .470000   .000000 69/07/10 71/04/07
00610  NH3-N       TOTAL      MG/L                 37  .026757   .001188   .034464   1.28807   .005666   .140000   .000000 68/04/16 71/06/02
00615  NO2-N       TOTAL      MG/L                 31  .006000   .000092   .009592   1.59862   .001723   .050000   .000000 68/04/16 71/04/07
00620  NO3-N       TOTAL      MG/L                 32  .079937   .006962   .083441   1.04382   .014750   .300000   .000000 68/04/16 71/04/07
00625 TOT KJEL     N          MG/L                 12  .367500   .011330   .106441   .289636   .030727   .500000   .100000 68/04/16 69/09/13
00630 NO2&NO3      N-TOTAL    MG/L                  6  .090000   .012480   .111714   1.24127   .045607   .300000   .000000 71/01/08 71/06/02
00660 ORTHOPO4     PO4        MG/L                 12  .052500   .002366   .048641   .926494   .014041   .120000   .000000 70/07/12 71/06/02
00665 PHOS-TOT                MG/L P               36  .077277   .005422   .073633   .952836   .012272   .330000   .009999 68/04/16 71/06/02
00666 PHOS-DIS                MG/L P               19  .045263   .002004   .044767   .989040   .010270   .180000   .000000 69/07/10 71/04/07
00680 T ORG C      C          MG/L                 34  5.09412   77.5739   8.80761   1.72898   1.51049   48.0000   .000000 68/05/07 71/06/02
00681 D ORG C      C          MG/L                  1  2.00000                                           2.00000   2.00000 68/05/07 68/05/07
00720 CYANIDE      CN-TOT     MG/L                  1  .020000                                           .020000   .020000 68/04/16 68/04/16
00900 TOT HARD     CACO3      MG/L                 31  206.452   5260.57   72.5298   .351316   13.0267   408.000   89.0000 68/04/16 71/04/07
00910 CALCIUM      CACO3      MG/L                 12  116.333   4105.52   64.0743   .550782   18.4967   257.000   15.0000 68/04/16 69/07/08
00915 CALCIUM      CA,DISS    MG/L                  1  83.0000                                           83.0000   83.0000 71/01/08 71/01/08
00925 MGNSIUM      MG,DISS    MG/L                  2  8.00500   127.840   11.3066   1.41245   7.99500   16.0000   .009999 71/01/08 71/04/07
00930  SODIUM      NA,DISS    MG/L                 14  7.08571   6.24900   2.49980   .352795   .668100   11.0000   2.50000 68/04/16 69/11/13
00931  SODIUM      ADSPTION   RATIO                 2  .300000-.596E-07   .000000             .000000   .300000   .300000 69/10/16 69/11/13
00932  PERCENT     SODIUM     %                     2  8.00000   .000000   .000000             .000000   8.00000   8.00000 69/10/16 69/11/13
00935 PTSSIUM      K,DISS     MG/L                 29  2.20379   .427905   .654145   .296827   .121472   3.00000   .009999 68/04/16 71/04/07
00940 CHLORIDE     CL         MG/L                 30  2.71033   2.16735   1.47219   .543178   .268784   7.80000   .000000 68/04/16 71/04/07
00945 SULFATE      SO4-TOT    MG/L                 17  60.7059   918.597   30.3084   .499266   7.35086   130.000   19.0000 68/04/16 71/01/08
00950 FLUORIDE     F,DISS     MG/L                 11  .364545   .031827   .178402   .489384   .053790   .700000   .009999 69/07/10 71/04/07
00955  SILICA      DISOLVED   MG/L                  1  18.0000                                           18.0000   18.0000 71/01/08 71/01/08
00956  SILICA      TOTAL      MG/L                 10  12.3900   6.39437   2.52871   .204093   .799648   18.3000   9.50000 68/04/16 69/06/12
```

Table 29

```
STORET DATE 74/02/09
                                                          12353300
                                                          46 59 33.0 114 26 45.0  2
                                                          CLARK FORK NEAR ALBERTON MONTANA
                                                          30    MONTANA
                                                          PACIFIC NORTHWEST
                                                          CLARK FORK PEND OREILLE RIVER BASIN
                                                          112WRD              02111204
                                                           0000
INDEX 1310001  007520
MILES 0745.50 0219.80
PARAMETER                                 NUMBER    MEAN   VARIANCE STAN DEV CCEF VAR STAND ER  MAXIMUM   MINIMUM  BEG DATE END DATE
01000 ARSENIC    AS,DISS       UG/L           13  2.61538  5.75641  2.39925  .917362  .665433  8.00000   .000000 68/04/16 70/06/09
01005  BARIUM    BA,DISS       UG/L           12  .000000  .000000  .000000           .000000  .000000   .000000 69/07/10 70/06/09
01010 BERYLIUM   BE,DISS       UG/L            4  .000000  .000000  .000000           .000000  .000000   .000000 70/03/17 70/06/09
01020  BORON      B,DISS       UG/L           23  18.6830  264.314  16.2577  .870187  3.38997  80.0000   .009872 69/07/10 71/06/03
01025 CADMIUM     CD,DISS      UG/L           12  .016667  .003333  .057735  3.46410  .016667  .200000   .000000 69/07/10 70/06/09
01030 CHROMIUM   CR,DISS       UG/L           12  .000000  .000000  .000000           .000000  .000000   .000000 69/07/10 70/06/09
01034 CHROMIUM   CR,TOT        UG/L            2  .000000  .000000  .000000           .000000  .000000   .000000 69/10/16 69/11/12
01035 COBALT     CO,DISS       UG/L           12  .166667  .151515  .389249  2.33550  .112367  1.00000   .000000 69/07/10 70/06/09
01040 COPPER     CU,DISS       UG/L           37  13.9138  278.901  16.7003  1.20027  2.74552  69.0000   .000000 68/04/16 71/06/03
01042 COPPER     CU,TOT        UG/L            3  86.6667  17633.3  132.791  1.53220  76.6667  240.000   10.0000 70/10/06 71/04/07
01045   IRON     FE,TOT        UG/L           10  534.200   400537  632.880  1.18472  200.134  1900.00   10.0000 68/10/29 71/04/07
01046   IRON     FE,DISS       UG/L           22  43.1959  2623.48  51.2199  1.18576  10.9201  200.000   .000000 69/07/10 71/06/03
01049   LEAD     PB,DISS       UG/L           36  16.6366  1885.68  43.4244  2.61017  7.23741  203.000   .000000 68/04/16 71/06/03
01051 LEAD       PB,TOT        UG/L            3  15.6667  446.333  21.1266  1.34851  12.1974  40.0000   2.00000 70/10/06 71/04/07
01055 MANGNESE     MN          UG/L            5  66.0000  6580.00  81.1172  1.22905  36.2767  210.000   20.0000 69/07/10 71/04/07
01056 MANGNESE   MN,DISS       UG/L           18  45.8889  3796.81  61.6183  1.34277  14.5236  280.000   .000000 69/10/16 71/06/03
01060   MOLY     MO,DISS       UG/L           12  4.56667  44.1806  6.64685  1.45551  1.91878  20.0000   .000000 69/07/10 70/06/09
01065  NICKEL    NI,DISS       UG/L           12  3.08333  10.6288  3.26018  1.05736  .941134  10.0000   .000000 69/07/10 70/06/09
01075  SILVER    AG,DISS       UG/L           12  .416667  .810606  .900337  2.16081  .259905  3.00000   .000000 69/07/10 70/06/09
01080 STRONTIUM  SR,DISS       UG/L           22  241.455  4629.85  68.0430  .281805  14.5068  340.000   70.0000 69/07/10 71/06/03
01082 STRONTUM   SR,TOT        UG/L            3  123.333  6433.35  80.2081  .650336  46.3082  200.000   40.0000 70/10/06 71/04/07
01085 VANADIUM    V,DISS       UG/L           12  .725000  .074773  .273447  .377168  .078937  1.00000   .200000 69/07/10 70/06/09
01090   ZINC     ZN,DISS       UG/L           36  48.5889  4707.66  68.6124  1.41210  11.4354  385.000   .000000 68/04/16 71/06/03
01092 ZINC       ZN,TOT        UG/L            3  163.333  18033.4  134.288  .822174  77.5314  260.000   10.0000 70/10/06 71/04/07
01105 ALUMINUM    AL,TOT       UG/L            3  66.6667  3333.34  57.7350  .866026  33.3333  100.000   .000000 69/07/10 69/09/18
01106 ALUMINUM    AL,DISS      UG/L            9  77.3555  5185.64  72.0114  .930914  24.0038  213.000   5.20000 69/10/16 70/06/09
01145 SELENIUM   SE,DISS       UG/L           12  3.78333  5.02153  2.24088  .592303  .646886  6.00000   .000000 69/07/10 70/06/09
31501 TOT COLI   MFIMENDO     /100ML          21  243.381   207787  455.837  1.87293  99.4717  2000.00   3.00000 69/07/10 71/06/03
31503 TOT COLI   MFDLENDO     /100ML          15  714.666   673622  820.745  1.14843  211.915  2300.00   15.0000 68/04/16 69/07/08
31616 FEC COLI   MFM-FCBR     /100ML          18  38.2778  3698.68  60.8168  1.58883  14.3347  230.000   .000000 69/10/16 71/06/03
70300 RESIDUE    DISS-180    C    MG/L        15  211.400  2789.12  52.8121  .249821  13.6360  262.000   79.0000 69/07/10 71/01/07
70302 DISS SOL   TONS/DAY                     18  2764.33  3514842  1874.79  .678207  441.892  7700.00   938.000 69/07/10 71/04/07
70303 DISS SOL   TONS PER    ACRE-FT          16  .269375  .009860  .099295  .368615  .024824  .360000   .000000 69/07/10 71/04/07
70507  PHOS-T     ORTHO       MG/L P          24  .017917  .000205  .014304  .798360  .002920  .068000   .000000 68/04/16 71/06/03
71845 AMMONIA    TOT-NH4       MG/L            4  .030000  .002200  .046904  1.56345  .023452  .100000   .000000 71/02/02 71/06/03
71850 NITRATE    TOT-NO3       MG/L           16  .512500  .305166  .552419  1.07789  .138105  2.20000   .100000 69/07/10 70/12/01
71855 NITRITE    TOT-NO2       MG/L           14  .016428  .000055  .007450  .453453  .001991  .030000   .000000 69/07/10 71/04/07
71890 MERCURY    HG,DISS       UG/L           11  .083636  .009325  .096569  1.15463  .029117  .300000   .000000 70/07/11 71/06/03
71900 MERCURY    HG,TOTAL      UG/L            7  .157143  .006191  .078680  .500690  .029738  .300000   .100000 70/11/03 71/06/03
```

Table 29 (Cont.)

```
STORET DATE 74/02/09                                              12353300
                                                                  46 59 33.0 114 26 45.0  2
                                                                  CLARK FORK NEAR ALBERTON MONTANA
                                                                  30     MONTANA
                                                                  PACIFIC NORTHWEST
                                                                  CLARK FORK PEND OREILLE RIVER BASIN
                                                                  112WRD                  02111204
                                                                   0000
INDEX 1310001  007520
MILES 0745.50 0315.60
PARAMETER                              NUMBER   MEAN   VARIANCE STAN DEV COEF VAR STAND ER MAXIMUM  MINIMUM  BEG DATE END DATE
00010  WATER      TEMP      CENT         50  7.96039  38.7137  6.22203  .781624  .879928  21.0000  .000000 68/04/16 71/06/03
00020   AIR       TEMP      CENT         22  11.4318  82.6261  9.08989  .795129  1.93797  33.5000  1.50000 69/07/10 71/06/03
00060  STREAM     FLOW      CFS          42  6970.00 .8066E+08 8981.29  1.28856  1385.84  41400.0  1510.00 69/07/10 71/06/03
00070   TURB      JKSN      JTU          31  6.53226  73.9156  8.59742  1.31615  1.54414  45.0000  .500000 68/04/16 70/10/06
00080  COLOR      PT-CO     UNITS        32  8.65625  64.8726  8.05435  .930434  1.42382  30.0000  .009999 68/04/16 71/04/07
00095 CNDUCTVY    AT 25C    MICROMHL     41  287.585  8309.37  91.1558  .316969  14.2361  400.000  .009936 68/04/16 71/06/03
00300    DO                 MG/L         38  10.5223  2.81081  1.67655  .159332  .271972  13.8000  7.60000 68/04/16 71/06/03
00301    DO       SATUR     PERCENT      14  96.6428  26.2500  5.12347  .053015  1.36931  106.000  87.0000 68/07/24 69/07/08
00310   BOD       5 DAY     MG/L         23  1.64782  .795246  .891821  .541212  .185958  4.80000  .800000 69/07/10 71/06/03
00400    PH                  SU          40  7.71517  1.68026  1.29625  .168013  .204955  8.50000  .089999 68/04/16 71/06/03
00410  T ALK      CACO3     MG/L         37  92.4324  758.035  27.5324  .297865  4.52630  159.000  43.0000 68/04/16 71/06/03
00425 HCO3 ALK    CACO3     MG/L         15  85.5333  444.844  21.0913  .246586  5.44576  120.000  50.0000 68/04/16 69/07/08
00430 CO3 ALK     CACO3     MG/L          1  23.0000                                     23.0000  23.0000 68/08/20 68/08/20
00440 HCO3 ION     HCO3     MG/L          1  62.0000                                     62.0000  62.0000 71/06/03 71/06/03
00605  ORG N        N       MG/L         17  1.27293  16.5244  4.06502  3.19343  .985913  17.0000  .009999 69/07/10 71/04/07
00610  NH3-N      TOTAL     MG/L         39  .045897  .006281  .079255  1.72680  .012691  .460000  .000000 68/04/16 71/06/03
00615  NO2-N      TOTAL     MG/L         32  .006156  .000096  .009782  1.58893  .001729  .050000  .000000 68/04/16 71/04/07
00620  NO3-N      TOTAL     MG/L         33  .094939  .011276  .106189  1.11849  .018485  .500000  .000000 68/04/16 71/04/07
00625 TOT KJEL      N       MG/L         14  .417142  .027330  .165317  .396308  .044183  .700000  .200000 68/04/16 69/05/13
00630 NO2&NO3   N-TOTAL     MG/L          6  .055000  .002430  .049295  .896285  .020125  .100000  .009999 71/01/07 71/06/03
00660 ORTHOPO4    PO4       MG/L         12  .047500  .001730  .041588  .875539  .012005  .120000  .009999 70/07/11 71/06/03
00665 PHOS-TOT             MG/L P        37  .084378  .008094  .089964  1.06621  .014790  .520000  .009999 68/04/16 71/06/03
00666 PHOS-DIS             MG/L P        19  .040000  .001589  .039861  .996525  .009145  .170000  .000000 69/07/10 71/04/07
00680 T ORG C       C       MG/L         35  6.58286  146.973  12.1232  1.84164  2.04920  54.0000  .000000 68/05/07 71/06/03
00681 D ORG C       C       MG/L          1  2.00000                                     2.00000  2.00000 68/05/07 68/05/07
00720 CYANIDE     CN-TOT    MG/L          1  .020000                                     .020000  .020000 68/04/16 68/04/16
00900 TOT HARD    CACO3     MG/L         32  146.906  2704.02  52.0002  .353969  9.19243  285.000  56.0000 68/04/16 71/01/07
00910 CALCIUM     CACO3     MG/L         12  90.8333  2044.34  45.2144  .497773  13.0523  186.000  19.0000 68/05/07 69/07/09
00915 CALCIUM    CA,DISS    MG/L          1  55.0000                                     55.0000  55.0000 71/01/07 71/01/07
00925 MGNSIUM    MG,DISS    MG/L          2  5.50500  60.3901  7.77110  1.41164  5.49500  11.0000  .009999 71/01/07 71/04/07
00930  SODIUM    NA,DISS    MG/L         16  7.04374  3.98662  1.99665  .283465  .499163  9.70000  3.10000 68/04/16 69/11/12
00931  SODIUM    ADSRPTION  RATIO         2  .300000-.596E-07 .000000           .000000  .300000  .300000 69/10/16 69/11/12
00932  PERCENT    SODIUM    %             2  10.5000  .500000  .707107  .067343  .500000  11.0000  10.0000 69/10/16 69/11/12
00935  PTSSIUM   K,DISS     MG/L         26  1.94230  .189692  .435537  .224237  .085416  2.50000  1.08000 68/04/16 70/06/09
00940 CHLORIDE     CL       MG/L         32  2.70031  1.38888  1.17853  .436452  .208338  5.50000  .009999 68/04/16 71/04/07
00945 SULFATE    SO4-TOT    MG/L         20  41.4500  224.788  14.9929  .361711  3.35252  72.0000  16.0000 68/04/16 71/01/07
00950 FLUORIDE   F,DISS     MG/L          9  .333333  .007500  .086604  .259813  .028868  .500000  .200000 69/07/10 71/01/07
00955  SILICA    DISOLVED   MG/L          1  14.0000                                     14.0000  14.0000 71/01/07 71/01/07
00956  SILICA     TOTAL     MG/L         12  12.1958  4.12751  2.03163  .166584  .586480  17.1000  9.50000 68/04/16 69/06/11
```

The results of the biochemical oxygen demand test which measures the relative oxygen requirements of municipal and industrial wastes, indicated the concentrations in the Clark Fork River from Missoula to the station downstream of Alberton, a distance of 62.6 km (39.1 miles), to be within a relatively narrow range of 1.3 - 3.0 mg/l (Figure not included with this environmental impact statement). Although the BOD concentrations in the side channel near the HW ponds reached an average of 5.1 mg/l (maximum 16.2 mg/l), only a slight increase from 1.3 to 1.8 mg/l was evident in the river.

Coliform criteria applicable to the reach of the Clark Fork River included in this study require that the average density of total coliform organisms be less than 1000/100 ml. Results of the study indicated that the total coliform desities remained less than this limit throughout the study reach.

No samples for dissolved oxygen testing were taken from the stream bottom as mixing is usually complete in rivers and the 200 benthos population does not indicate a dissolved oxygen depression.

Fecal coliform organisms, indicators of recent pollution, were found at all sampling locations. Mean densities were less than 100/100 ml at all river locations with the exception of Station CF-DS, downstream of the discharges from the Missoula Wastewater Treatment Plant and the Dailey Packing Plant, where the mean density was 144/100 ml (maximum 7,300/100 ml). A high density of fecal organisms (mean 190/100 ml) was present in the side channel of the river containing seepage from the HW ponds, however, no increase in coliform densities in the river could be attributed to the pond seepage.

Although color determinations in the reach of the Clark Fork River did not exceed 5 units above background (that found in the upstream control station), it can be seen that wastes entering the river in the vicinity of the HW ponds produced an incremental increase of 5 units to a color intensity of about 10 units. This condition persisted downstream to the limit of the study reach.

Conductivity measurements showed a small increase in the average conductivity from 309 to 316 umhos (Station CF-1 to Station CF-3) within the reach of river which receives wastes from the HW ponds. A conductivity cross-section made at Station CF-3, opposite the HW ponds, showed that the conductivity progressively increased from the west bank of the river to the east bank where the ponds are located.

It should be noted that dissolved oxygen samples during the EPA study were obtained during daylight hours, and night time samples would have given lower DO concentrations.

Date	Investigating Group	Parameters Measured
July 23-August, 1973	U.S. Environmental Protection Agency (49)	DO, temperature, pH, specific conductance, BOD (5-day), coliforms (total and fecal), fecal streptococcous, qualitative and quantitative aquatic invertebrates
August 2 & 3, 1974	Water Quality Bureau and Montana Fish and Game Department	DO, BOD, toxic metals, temperature

The Department of Health and Environmental Sciences Clark Fork River survey of May, 1973, was during the direct discharge of wastewaters by HW. The ratio of river to wastewater at this time was approximately 170:1. Results of this survey (Table 30) indicated a reduction in dissolved oxygen, a biochemical oxygen demand, and a significant increase in color downstream from the plant.

At the request of SDHES, the Environmental Protection Agency made a stream survey of the Clark Fork River in the vicinity of the HW plant in July 23 to August 3, 1973. The survey was requested at this time because stream flow in July and August of 1973 was the fifth lowest in 44 years of record. Average daily river flow during this period ranged from 1,280 to 1,690 cfs (cubic feet per second) and averaged 1,465 cfs.

The following conclusions are taken from the EPA report (49):

> Results of the grab samples indicated that at no time during the study did the dissolved oxygen concentrations in the Clark Fork River fall below the 7.0 mg/l criteria. The plot of average dissolved oxygen concentrations at each sampling station (Figure not included with this environmental impact statement) indicates a fairly uniform dissolved oxygen concentration throughout the study reach with a variation of only 1.3 mg/l from upstream of all sources of wastes (Station CF-US) to the downstream limit of the study (Station CF-8). A variation of only 0.4 mg/l occurred in the reach from upstream of the HW ponds (Station CF-1) to the furthermost downstream station (Station CF-8).

TABLE 30

RESULTS OF STREAM SURVEY ON CLARK FORK RIVER - May 30 and 31, 1974
by the Water Quality Bureau, Department of Health and Environmental Sciences

SAMPLE LOCATION							
Description	Estimated Miles Above or Below Pulp Mill Discharge	DATE	TIME	RIVER TEMPERATURE °F	DO mg/1	BOD mg/1	COLOR* units Pt-Co
At Harpers Bridge south side	3 above	5-30-73	1:45p	57	9.1		
			6:30a	57	8.4	0.9	5
At Marcure's Ranch below pulp mill	1 below	5-30-73	2:45p	58	8.6		
One mile below Huson north side	9 below	5-30-73	5:00p	60	8.4	2.2	18
		5-31-73	6:00a	58	8.0	1.5	19
Below Alberton at west bound highway rest stop	25 below	5-30-73	5:30p	60	8.0	1.7	17
Below Alberton at east bound highway rest stop	26 below	5-31-73	5:30a	58	8.0	1.1	16
Above Superior about 1 mile on north side	53 below	5-30-73	6:30a	58	8.8	2.0	13
Above Superior at interstate bridge east side	52 below	5-31-73	4:45a	59	7.8	1.0	11
At St. Regis highway bridge - east side	67 below	5-30-73	8:15p	59	8.6	2.2	14
East of Paradise 3 miles at Highway 200 bridge - east side	91 below	5-30-73	9:00p	59	8.6	2.2	14

*Color determinations were not made within the maximum recommended storage time.

The April to June, 1973 investigation of the Clark Fork River by the Montana Department of Fish and Game gave the following results:

> A comparison of diurnal dissolved-oxygen sags prior to and during a HW kraft mill waste discharge shows a marked reduction in the amount of dissolved-oxygen below the kraft mill effluent discharge points during the discharge period (see Figures and -not included in this environmental impact statement). A dissolved-oxygen reading of 6.9 ppm occurred at the Marcure Ranch station during the 4:00 a.m. sampling period on May 24, 1973 while the DO at the Harpers Bridge Station (8.5 ppm) was 1.6 ppm higher (Figure -not included in this environmental impact statement). The 6.9 ppm level of dissolved-oxygen was in violation of the Water Pollution Control and Helena personnel were notified. Apparently up until this period only daily noon samples for dissolved-oxygen were being determined by HW. Subsequent diurnal sampling by HW and the Department of Fish and Game showed some discrepancy in results, however, comparisons of dissolved-oxygen obtained at selected stations found HW generally higher than other participants (see memo by Wipperman, May 31, 1973). Following this meeting, diurnal sampling showed a sag of up to 1 ppm.
>
> Temperature data indicate an increase in temperature between Harpers Bridge and the Marcure Ranch station.
>
> Turbidity determinations fluctuated and showed no consistent trends.
>
> Conductivity data shows a definite increase between Harpers Bridge and the Marcure Ranch during the discharge period. However, lower levels at Huson would indicate that dilution occurs between these sampling points.

Dissolved oxygen values reported by the Fish and Game Department on May 23 and 24 were during a period where the radio of river flow to wastewater discharge was approximately 130:1.

HW reported the results of 1973 DO tests as follows:

> HW conducted additional diurnal oxygen measurements of the Clark Fork River during the entire direct discharge period of 1973. No violation of the water quality standards occurred during this period.

On August 2 and 3, 1973, the SDHES, in cooperation with the Department of Fish and Game did a 24-hour DO, BOD and temperature survey of the Clark Fork River above and below the HW plant. Results from stations above and below the plant are shown in Figures 19 and 20 , respectively. Results showed

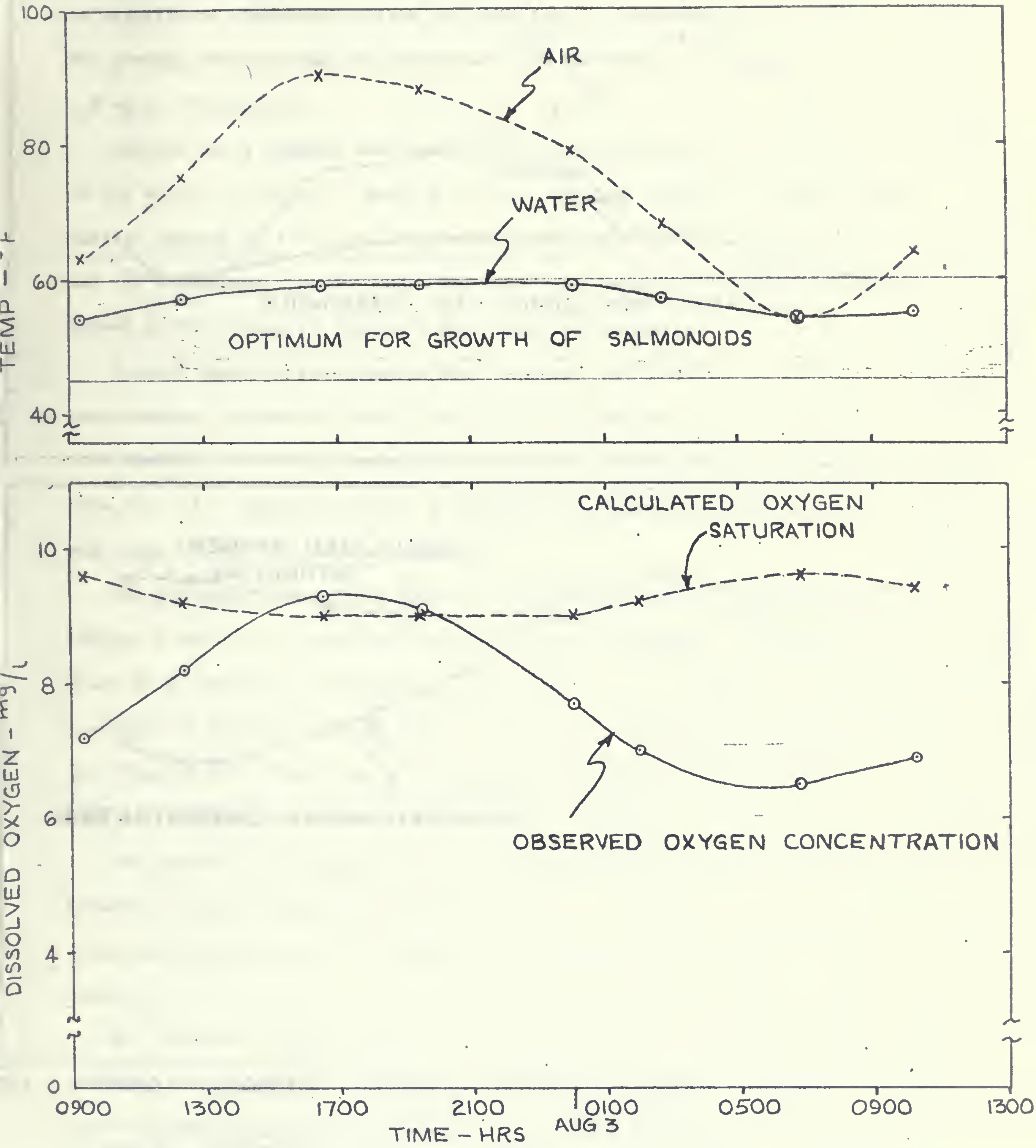


FIGURE 19 . DISSOLVED OXYGEN AND TEMPERATURE DIURNAL VARIATIONS FOR CLARK FORK R AT HARPER'S BRIDGE

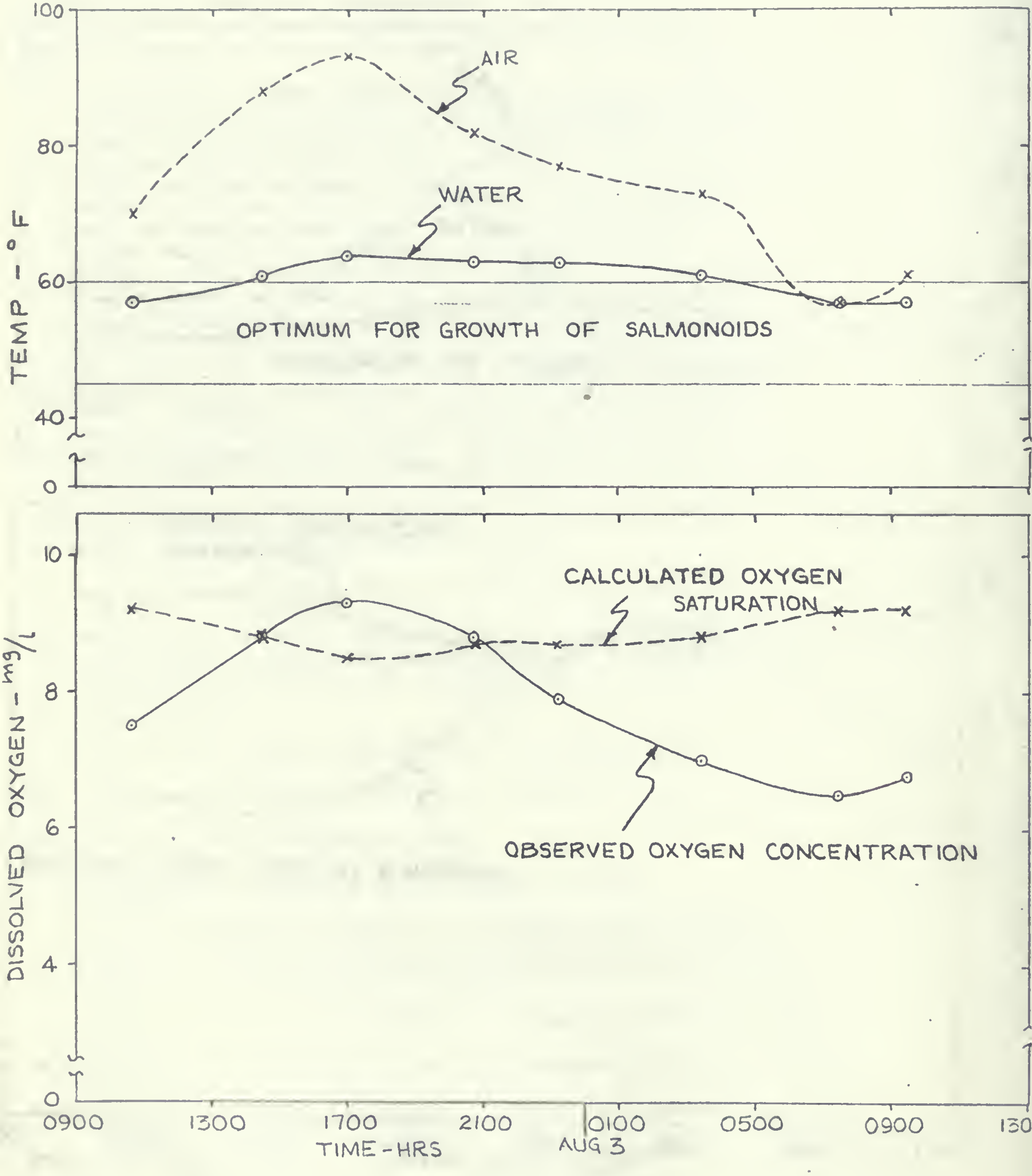


FIGURE 20 . DISSOLVED OXYGEN AND TEMPERATURE DIURNAL VARIATIONS FOR CLARK FORK R AT HUSON no significant change in DO from the upstream to the downstream stations. The average BOD upstream and downstream from the mill was 1.0 mg/1 and 0.8 mg/1, respectively.

Several water samples were taken from the Clark Fork River by SDHES in the winter of 1973-74. Results of this sampling indicated no significant quality changes in the river between the upstream station (above the mill) and the downstream station (below the mill hear Huson). The samples also showed no violations of Montana's water quality standards.

Aquatic invertebrates samples were collected and analyzed by the U.S. Environmental Protection Agency from the Clark Fork River at 12 locations from Missoula to a point downstream of Alberton. THis sampling was done from July 23 to August 3, 1973. A summary of the sampling results above and below the mill is shown in Table 31.

The Ecological Consulting Service (ECS), under contract to HW performed a similar study at six locations from just below the Missoula sewage treatment plant to St. Regis. This study was done from July 13 to August 7, 1973. A summary of these results is shown in Table 31 . Community diversity indices were done by ECS. There was a slight decrease below the mill. The study also included cursory examinations of algal populations.

The twofold discrepancy in the percentage of sensitive invertebrates between sources shown in the table must be due to differences in substrata, locations or techniques as the same sensitive specie were collected in both cases.

Dr. Clarence Gordon, professor at the University of Montana, Missoula, Montana, collected rainbow trout from four locations on the Clark Fork River between October 17 and November 15, 1973. At this time, there was no direct discharge from the mill, and the river flow varied from 1860 to 4000 cfs. The flavor of these fish was tested by the Department of Food Science and Technology, Oregon State University. Results of these tests (Table 32) indicated fish from immediately below the sewage plant had a definite abnormal taste but fish from below the HW mill tasted as good as control fish. A similar series of taste tests were carried out during the direct discharge period in 1973 by the Ecological Consulting Service under contract to HW. The results of these tests were inconclusive, but indicated the direct mill discharges may affect the taste of fish. SDHES, with the cooperation of the State Fish and Game Department, performed taste tests during May, 1974. For this test, rainbow trout were held in cages placed at three locations in the Clark Fork River. The three locations were:

1. Just above Harper's Bridge (three miles above discharge).
2. In the river about 300 yards below a side channel mouth (one mile downstream from discharge).
3. In the river about 3.5 miles below the discharge.

The flavor of these fish also was tested by the Department of Food Science and Technology of Oregon State University. The flavor and desirability of the fish held below the mill discharge were significantly lower than control fish (Table 33). At this time, the stream flow was about 15,000 cfs and the mill discharge was from about 44 cfs to 80 cfs.

Table 31
SUMMARY OF AVAILABLE BIOLOGICAL DATA

			Above the Mill		Below the Mill		
Year	Month	Sample Method	Total #/ft^2	% Sensitive	Total #/ft^2	% Sensitive	Source
1973	July-August	Surber	535	30	1221	24	1
1973	July-August	Surber	253	61	828	51	2

---

1. EPA - 1973
2. Ecological Consulting Service - 1973

Table 32
RESULTS OF TASTE TESTS OF RAINBOW TROUT HELD AT VARIOUS LOCATIONS IN THE CLARK FORK RIVER FROM MAY 2, TO MAY 7, 1974

SCORE RANGES: 7 - No off-flavor to 1 - extreme off-flavor
7 - Very desirable to 1 - very undesirable

Sample*	Off-Flavor	Desirability
A	6.1	5.5
B	4.76**	3.73**
C	4.84**	3.92**

*A - just above Harper's Bridge
B - At the Marcure Ranch
C - About 3.5 miles below the discharge
**Significantly different from the control at the one percent level

Table 33
RESULTS OF TASTE TESTS OF RAINBOW TROUT COLLECTED FROM THE CLARK FORK RIVER BETWEEN OCTOBER 17 TO NOVEMBER 15, 1973

SCORE RANGES: 7 - No off-flavor to 1 - Extremely off-flavor
7 - Very desirable to 1 - Very undesirable

Sample*	Off-Flavor	Desirability
A	6.37	5.67
B	5.05**	4.30**
C	2.27**	1.65**
D	6.07	5.42

*A - Above the Russell Street Bridge - used as a control
B - Between the Russell Street Bridge and Missoula sewage treatment plant (above Daily's Meat Plant)
C - Up to one mile below sewage treatment plant
D - Up to two miles below HW plant
**Significantly different from the control at the one percent level.

Algal bioassays have been performed by SDHES using Clark Fork River water from above Drummond. These show nitrogen was limiting. Chemical data from the discharge area indicate nitrogen should be limiting.

Based on available biological data, mill wastes increase total numbers of aquatic invertebrates and slightly decrease the percentage of sensitive forms in the Clark Fork River immediately downstream from the mill. These studies have not included adequate examinations of algal populations and algal productivity or of the biomass of aquatic invertebrates. No data are available on the effects of the HW discharges on fish populations or productivity. Taste of fish from the Clark Fork River below HW apparently is affected by present mill discharges during the direct discharge period.

IMPACT OF WASTES ON WATER QUALITY

After expansion, waste flows and loads from the mill (Table 34) can enter the river via groundwater, as a direct discharge, or as a combination of the two. To evaluate potential effects on the river, several discharge conditions are considered. All calculated concentrations assume use of an aerated waste system and complete mixing with river water. Concentrations in the river from the existing disposal scheme are shown in Table 34 for comparison purposes. For the present disposal case a 150:1 dilution ratio is used for calculations and a direct discharge to the river is assumed.

CASE 1 ALL DISPOSAL BY SEEPAGE - STREAM FLOW 7 DAY-10 YEAR LOW (930 CFS)

This condition (Table 34) produces concentrations in the river water that would not violate applicable water quality standards. Color at 4.8 cu (color units) is the parameter nearest the maximum limit. It is assumed in this case than an 85 percent color removal would occur in the groundwater system.

CASE 2 - ALL DIRECT DISCHARGE - 7 DAY/10-YEAR RIVER FLOW

The rate of direct effluent disposal to the river system would be limited by the allowable increase in stream color of 5 cu. Direct discharge in this case would be limited to 3.2 mgd (5.0 cfs).

It is apparent that at the 7-day, 10-year low flow, the entire plant effluent of 21.6 mgd (33.5 cfs) must be disposed of by seepage. A variety of combinations of seepage, direct discharge and storage would be used to meet stream water quality standards.

Table 34

CALCULATED INCREASE IN CONCENTRATION OF SELECTED PARAMETERS IN THE CLARK FORK RIVER DUE TO DISPOSAL OF HW WASTES+ AFTER PLANT EXPANSION

PARAMETER	EXISTING DISPOSAL SYSTEM*	7-day/10 yr. low flow (930 cfs)		Aver. annual flow (5448 cfs)		APPLICABLE WATER QUALITY STANDARDS**
		ALL SEEPAGE	DIRECT DISCHARGE	ALL SEEPAGE	DIRECT DISCHARGE	
BOD	2.65	0.41	0.10	0.07	0.10	none
TSS	0.79	0.0	0.15	0.0	0.16	none
TDS	15.0	65.6	10.1	11.6	10.1	500
Color	19.8	4.8	5.0	0.85	5.0	5 units increase
Sodium	3.4	9.8	1.51	1.74	1.52	none
Chloride	1.91	10.6	1.63	1.87	1.64	250
Sulfate	1.1	11.6	1.78	2.00	1.79	250
Phenol	0.002	0.0006	0.0005	0.0001	0.0005	0.001
Phosphorus as P	0.005	0.012	0.002	0.002	0.002	none
Nitrogen an N****	0.029	0.079	0.015	0.014	0.015	10.1***
Discharge	15.8 mgd	21.6 mgd	3.23 mgd	21.6 mgd	18.9 mgd	

+All concentrations in mg/l (milligram/liter) except as indicated

*Assumes a 150:1 dilution ratio (river water to wastewater) for comparison purposes.

**Montana Water Quality Standards, MAC 16-2.14(10)-S14480

***Nitrage Nitrogen applicable only to domestic water supply.

****All forms of nitrogen included except for last column.

CASE 3 - ALL DISPOSAL BY SEEPAGE AT AVERAGE ANNUAL STREAM FLOW (5448 CFS)

In this case, no water quality standards would be violated.

CASE 4 - ALL DIRECT DISCHARGE AT AVERAGE ANNUAL STREAM FLOW

This condition would result in a violation of color standards. A discharge of 18.9 mgd (29.3 cfs) or 88 percent of the plant daily effluent flow would be the maximum allowed if a 5 color unit increase in the river was adhered to. At a river flow of approximately 6225 cfs, the entire daily plant flow could theoretically be discharged directly to the river and not violate water quality standards.

None of the cases presented thus far has considered the large number of organic compounds common to kraft wastes. It is known that these compounds can produce tastes in fish flesh and can have significant biological effects. Shumway (1966) and Shumway and Chadwick (1971) say that untreated Kraft wastes affect fish palatability at concentrations of 1-2 percent by volume in natural wastes and treated (aerated Kraft wastes affect fish palatability at 9 to 12 percent. These data suggest that the HW mill wastes, after aeration, may have considerably less effect on fish palatability than at present. Biological effects of the many chemical compounds in Kraft wastes are poorly known and bioassays using Guppies are normally taken to measure toxicity. Additional treatement (aeration) of HW wastes will reduce waste toxicity, and the literature available suggests that it will not be a problem.

The overall hydrological impact of wastes that would be generated from an expanded mill operation depends on the reaction of the soil system and upper aquifer to infiltrate wastes. If the HW proposed wastewater treatment procedures were utilized, it is clear that an additional volume of poor quality water would be placed into the hydrological system; however, in-plant reductions accompanying the expansion would decrease some of the chemical constituents. Ground disposal significantly reduces organics, suspended material, color, and probably other constituents. Degraded groundwater is the environmental price of this disposal option. The size of this contaminated groundwater body can only be roughly estimated at this time. Pilot disposal tests and additional investigations of the ground system are underway but are not sufficiently advanced to permit a quantitative estimation of the groundwater impact.

Direct disposal into the Clark Fork River utilizes dilution to abate the possible environmental effects. Poor removal of color would occur. At low river discharges, the river could not accommodate the wastes without violation of Montana's color water quality standard. Color removal capability of the groundwater system, therefore, becomes important in the disposal problem. Physical-chemical treatment prior to disposal is another option that would be installed to influence total effluent color loads. Similarly, variations in plant operation can affect color loads. To meet Montana's Water Quality Standards, a combination of techniques could be used, including ground disposal, river disposal, physical-chemical treatment, and variations in plant operation. Until additional groundwater testing is completed, the degree of success of the proposed disposal technique is uncertain. Treatment techniques are available which would allow disposal of additional wastewater from the expanded mill without violation of Montana's Water Quality Standards. Rapid infiltration will have low operation and maintenance costs when compared to physical-chemical treatment. If it proved to be totally or partially unsuccessful, other treatment means could be installed to allow disposal without additional water degradation.

C. Social and Economic Considerations

The HW pulp and paper mill has been a source of public controversy ever since its installation. On the one hand, the plant furnishes jobs for the community, and on the other hand it causes pollution problems serious enough to keep many persons from wanting to live there.

Although the company has spent much money on pollution control, the odor problem caused by the plant seems to the human nose to be as bad as ever, according to many residents. Accordingly, many persons are reluctant to see the mill expand until it is demonstrated that the pollution problems will not expand proportionately.

After HW announced its expansion proposal in 1973, a group called the Concerned Citizens for a Quality Environment was formed. This group has been active in calling for further study of the proposed expansion. Within a period of approximately six weeks, approximately 7,000 persons signed the following CCQE petition:

> TO: Governor Tom Judge
> Lieutenant Governor Bill Christiansen
> Dr. John Anderson, Director, Montana State Department of Health and Environmental Sciences
> Mr. Benjamin F. Wake, Director, Environmental Sciences Division, Montana State Department of Health and Environmental Sciences
>
> "We strongly request that you use your good offices to ensure that there be at least a two year delay in granting any permit for the proposed expansion of the Hoerner Waldorf facilities in Missoula County. We are very concerned about futher potential environmental degradation (air, water and resources) which could ensue and believe that many questions must be answered before any permit is granted. In particular we feel that the proposed air monitoring system should show that the company will have complied with state standards for at least one full year. A comparable study of the water system is also a necessity. Finally, HW should be obliged to reduce its emmissions to the low levels already achieved by comparable companies.
>
> "The expansion of any facility in the Missoula Valley is something that will affect us for many years to come and careful, long-range planning is essential."

To further test public opinion in regard to the proposed expansion, a random telephone survey was taken in the fall. Of those sampled, 156 were in favor of the expansion, 195 were against, and 102 had no opinion.

ECONOMIC BENEFITS OF EXPANSION

There are at least two schools of thought as to how much the expansion would benefit Missoula. One school is led by Dr. Maxime Johnson, who was hired by HW to assess the economic ramifications of the proposed expansion in the "Environmental Impact Statement" issued by HW when it announced it would seek the expansion.

Basically, Dr. Johnson said that the expansion would offer significantly expanded high-wage employment opportunities to Missoula residents at little or no economic cost to them. The latest estimate of the expansion cost to HW is $60 million. The anticipated new employment at the mill would be 150 year round workers. The latest revision of the cost estimates is as follows, according to Dr. Johnson (50).

	Revised Estimate
Capital Expenditure	$60 million
Construction Employment (no. of workers)	
First Year	450
Second Year	670
Construction Wages, Total	$20.2 million
First Year	$8.1 million
Second Year	$12.1 million
Additional Property Tax Payments (Maximum)	$1,934,000
Additional Expenditures for Chips, Sawdust & Logging Residuals	$6.5 million
Additional Hogged Fuel Purchases	$700,000

Dr. Johnson said most of the jobs could be filled from the Missoula area. She said also that she did not expect the additional property tax payments to reach the above figure. The company plans to request a Class 7 classification for the added valuation attributable to pollution control equipment, as shown below, and the large increase in total property valuation in the Frenchtown school and rural fire districts might result in reduced levies, according to Dr. Johnson (50).

Air Pollution Control Facilities for Which Class 7 Tax Status Will Be Sought	Estimated Cost
Black liquor concentrator and building	$ 406,000
Non-condensible gas collection and incineration system for new evaporators and sawdust digester	70,000
Recovery boiler conversion to controlled odor	2,123,000
Precipitator including structures	1,958,000
#2 recovery dissolving tank vent	57,000
#2 power boiler scrubber and structure	1,117,000
Lime kiln scrubber	82,000
Tall oil vent scrubber	25,000
#3 slaker vent scrubber	29,000
Second stage cyclone	20,000
Entrainment separator washer hood vents	25,000
Condensate stripping system	240,000
TOTAL DIRECT COST	$6,152,000
Premium time	65,000
Escalation	524,000
Contingencies	314,000
Engineering	370,000
TOTAL	$7,425,000

Dr. Johnson wrote in the "Environmental Impact Statement":

> "The overall effect might be a combination of a substantially increased tax base in the county and the school district, plus a possible reduction in levies for taxpayers in the Frenchtown area.
>
> "Increases in the cost of public services provided to the mill are expected to be minimal. Heavier traffic on the county roads leading to the mill may result in larger maintenance costs. Fire protection will continue to be provided by the Frenchtown rural fire district. In both instances, the appropriate funds will receive increased revenue.
>
> "The demand for public services on the part of the 300 potential new Missoula County workers and their families should not be burdensome. The modest number of people involved in relationship to total county population should create no particular hardship. Many of the jobs will be filled by current residents, perhaps some of those presently unemployed. Jobs in derivative industries, particularly trade and service industries, often are filled by women; these potential workers may already be in the community. Should new mill workers come from outside the county and locate in the Frenchtown area, as many have done in the past, that school district might experience some growing pains. However, the increased revenue to the district should more than take care of the added costs. The impact on Missoula's District I would depend upon the geographic location of workers' residences. In some areas of the city, public school enrollments are leveling off; in others overcrowding still exists.
>
> "The possibility of some disruptive influence during and after the construction period, should the timing coincide with other large projects, has been referred to above.
>
> "Probable increases in state and local tax collections from individual workers employed at the mill and in supporting industries and increases in corporate license tax payments by the corporation to the state of Montana have not been estimated.
>
> "Some of the new workers may live outside the county; approximately 12% of Hoerner Waldorf's present employees do so."

In fiscal 1972, HW paid $276,659 in property taxes, including motor vehicle taxes. Of this amount, $58,000 went to Missoula County, $71,000 to the county school funds, $5,000 to the library and city-county planning funds, $110,000 to the Frenchtown school district, and $22,000 to the Frenchtown rural fire district.

Two independent economists, Dr. Thomas M. Power and Dr. Malinda Schaill, differ with Dr. Johnson regarding the actual economic impact of the development. They wrote in part: (51)

> "We wish to emphasize that we do not oppose the expansion of Hoerner-Waldorf or the wood-products industry. We argue instead that economic conditions are not so bad nor the benefit offered by an expanded pulp mill so great that Missoulians should be rushed into approving the expansion before its impact on the public resources of this valley is known as the environmental controls it plans to use to protect those resources are proved. We find the conventional optimism about industrial expansion and the conventional pessimism about Western Montana's economic situation dangerously misleading."

Power and Schaill summarized their critique of Dr. Johnson's economic assessment as follows: (52)

> "1. The long-run employment impact (of the expansion) will not be as large as suggested. In addition, many of the projected high-wage jobs will not go to Missoula Valley residents if the expansion is allowed to proceed immediately. Local residents will fill the lower-paying (but above average) jobs. Possibly 100 jobs for local residents are at issue.
>
> "2. As a result of the expected influx of almost 600 construction workers (and some of their families) into the area to build the plant and the expected migration of individuals from outside the area seeking high-wage jobs in a "high amenity" area, the actual employment situation in Missoula, as seen by current residents, may deteriorate. Competition for existing jobs may increase.
>
> "3. The construction phase of the expansion may well feed a building boom already underway. The infant city-county planning agencies cannot yet be expected to help plan this growth. The result will be the irretrievable commitment of county land and space resources in a way that will have a negative impact on future social and economic patterns in the Missoula Valley.
>
> "4. The Missoula Valley, when judged by national standards, is neither a low income area nor an area of retarded growth. This argument, therefore, should not be used to justify environmentally destructive growth.
>
> "5. The estimated number of additional jobs indirectly created by the expansion is uncertain. No real analysis lies behind the figure chosen in the impact statement.
>
> "6. The expansion of Hoerner-Waldorf or the building of a new pulp and paper mill in the region seems a certainty. Given the unique locational advantages of the area, delaying the building of the plant will not mean that the region will lost the expansion. This means that there is the possibility for the region to "have its cake and eat it too," i.e., to obtain the additional incomes for existing residents at minimal environmental costs.
>
> "7. A two to five year delay in the expansion is justified in terms of increased incomes for existing residents, more rational land-use

> planning in the Missoula Valley, and reduced environmental costs (air and water pollution). There is no serious long-run cost associated with such a delay.
>
> "8. Missoula and Western Montana's present and future growth is at least partially tied to its status as a high amenity region. To undermine this in the pursuit of questionable short-run gains may damage growth potentials in the future.

Following issuance of the draft statement and during the continuing lay-off of wood products workers in Missoula, Power took further issue with those who advocate approval of the expansion solely on the ground that it would be a boon to the unemployed in the area (53).

He noted that construction plans in the area are running far ahead of last year, indicating that most construction workers in the area are employed already. If construction at HW were to begin immediately, many of the construction workers would have to come from outside the area. Laid off mill workers would not have the skills necessary to the HW construction phase, according to Power.

Power further noted that the optimism in the housing industry that HW will bring in 300 workers who will all need new houses seems misplaced. HW insists that most of the work force at the mill would be from Missoula, and therefore, would not need new housing.

Power said further:

> "The $60 million spent on the construction of the HW addition will provide a healthy shot in the arm to local businesses. This will indirectly lead to greater employment opportunities in the service, retail-wholesale, and support industries. Although these are low-paying jobs, this will allow mill workers or other members of mill workers' families to find new jobs. But these would be temporary jobs, the boom would be a temporary boom, benefiting the owners of the businesses but providing no stable employment opportunities for valley citizens. Further, the retail-wholesale sector is already over-built. This means that a substantial increase in trade is possible without any significant increase in employment.
>
> "The point I am trying to make is that the HW expansion is not a solution to the current economic problems in Missoula. That expansion, if it is timed well and doesn't further degrade the Missoula environment, would benefit the long run economy of Missoula and Western Montana.

"The decision on the Hoerner-Waldorf expansion should not be made on the basis of short run economic gain (mostly to the business community). It should be made on the basis of the long run health of the Missoula environment.

"That long run health includes the economic security (or insecurity) of Missoula area workers as much as it does the quality of the air we breath in Missoula. Unemployment and poverty seriously degrade the human environment. But the Hoerner-Waldorf expansion will not put the mill and wood workers back to work any more than a less careful and more rapid selling of the lumber in our forests would. Claims that they will are merely political ploys on the part of the business community to use the very real fears of the Missoula worker force to get labor's political support for their long run plans."

D. Wood Waste Supply

HW's primary source of chips is residue from primary forest product wood processing plants. The two major manufacturing processes are sawmill and plywood operations.

Since the advent of the pulp and paper operations in Missoula County in 1957, the lumber and plywood industry has grown dramatically. Montana lumber production in 1957 was 832.2 million board feet generating a wood waste residue potential to produce 308 thousand BDUS* of chips. The plywood industry was in its infancy and was producing less than 50 million 3/8 inch square feet and could potentially produce 34 thousand BDUS of chips. There was a potential supply totalling approximately 342 thousand BDUS.

Montana sawmills in 1971 produced 1,397 million board feet and generated a potential of approximately 684 thousand BDUS of chips. This presents an increase in lumber production of almost 70 percent. Chip potential was increased 100%.

Plywood production in 1971 was 415.2 million 3/8 inch square feet and produced a potential of approximately 104 thousand BDUS of chips. This represents an increase of more than 700 percent in plywood production and about 206 percent in potential chip production.

As yields improve in plywood manufacturing the salvable wood for chipping will diminish. This is because of the type of technology applied to plywood manufacturing.

HW's present production, rated at 1,100 tons per day for 350 operating days, will gross a total production of 385,000 tons of pulp and paper per year and require 668 thousand BDUS of chips. Factors that determine raw materials requirements are yield, wood market trends, mix (chip and sawdust ratios) and other contingencies. HW outlines its present committed supply as 95.0 percent wood waste chips, 4.8 percent sawdust and 0.2 percent roundwood chips to produce 1,100 tons of pulp and paper.

---

*Bone-Dry-Units equivalent to 2400 pounds of oven dry wood.

Table 35

Production Committed to Hoerner-Waldorf Corporation that is a Potential Source of Sawdust Residue Production (1971 Basis)

	No. of	MMBF Lumber	MMBF 3/8"	Thousand BDUS		
Operation	Plants	Scale	Sq. Ft.	Chips	Sawdust	Total
Total All Sources	36	1039	362	688	538	1,046
				--thousand short tons--		
Potential Yield Of Kraft Pulp				396	200	602

Source: Directory of the Forest Products Industry, 54th Edition, Miller Freeman Publications, San Francisco, CA, and random sampling.

Forty-eight percent pulp and paper yield is an accepted recovery level for Montana wood species. The present pulping facility is capable of using wood chips from any conifer tree specie except western red cedar (Thuja plicata) within the area. Usable species include Douglas-fir, Western larch, Lodgepole pine, Englemann spruce, Eastern white pine, Ponderosa pine, and Alpine fir.

A study of the present chip supply potential committed to HW encompasses plants with a production capability of approximately 636 thousand BDUS of chips per year. In order to balance fluctuations in chip flow due to market trends and other contingencies, HW installed a Nicholson Utilizer that is capable of chipping 90 thousand BDUS per year.

The plant expansion proposes that the present capacity of 1,100 tons per day be increased to 1,850 tons per day. The expansion as outlined in Table would require 1,124 thousand BDUS of chips and sawdust per year. HW would utilize an additional volume of 187 thousand BDUS of sawdust and 50 thousand cords of roundwood per year. Markets for primary and secondary wood products and competition for raw materials will ultimately determine the balance of other sources of supply that would be tapped.

Table 36

Proposed Expansion

	Annual Pulp & Paper Production tons/yr	Wood Usage BDUS/year
Present Mill 1,100 tons/day	385,000	668,400
Proposed Mill 1,850 ton/day	647,500	1,124,130

As planned, the expansion will utilize first the unused primary manufacturing wood waste residues (chips and sawdust). Next, depending upon forest practices, it is most likely that round slash wood waste accumulations from the annual harvest would be utilized. Finally, the readily accessible dead standing and down wood waste would be taken.

UNUSED PRIMARY MANUFACTURING RESIDUES

There is a significant change in pulp and paper raw material availability. The source of supply within Region I is rapidly increasing. The total source of chip supply from 54 primary manufacturing facilities will produce 1,654 thousand BDUS of chips and sawdust.

Table 37 projects the potential availability of manufactured chips and sawdust. The 49 Montana plants reviewed produce more than 95 percent of the total lumber from Montana in 1971. In 1971 sawdust made up about 37 percent of the potential BDU tonnage. By 1980 it will represent only about 25 percent of the potential tonnage. HW studies show conclusively that it can utilize 20 percent sawdust for pulp in the production of linerboard and between 25 and 30 percent sawdust in the production of Kraft sack paper.

Table 37

Pulp and Paper Raw Material Source Projection of Residues Within Hoerner-Waldorf Corporation's Area of Influence (1971 Basis).

				Thousand BDUS		
Operation	No. Plants	MMBF Lumber Scale	MMBF 3/8" sq. ft.	Chips	Sawdust	Total
Total all Sources	55			1,137	607	1,744
				--thousand short tons--		

(cont.) Operation	No. Plants	MMBF Lumber Scale	MMBF 3/8" sq. ft.	Thousand BDUS Chips	 Sawdust	 Total
Potential Yield of Kraft Pulp				655	350	1,005

Source: Directory of the Forest Products Industry, 54th Edition, Miller Freeman Publications, San Francisco, CA, and random sampling.

Also available to HW will be logging slash and dead standing and down timber.

LOGGING SLASH WOOD WASTE

The U.S. Forest Service estimates that the amount of wood fiber 4 inches in diameter and larger left each year on logged areas amounts to 7 million tons in Region I, alone. There are 11 national forests in Montana and the total from the nine reporting show an annual logging slash wood waste of 743,000 cords. There is no information available on Kaniksu or Kootenai.

The Beaverhead, Bitterroot, Flathead and Lolo National Forests in close proximity to Missoula, reported a combined total annual logging slash waste of 541,000 cords. These four account for about 73 percent of the total reported wood waste supply available.

The total wood waste is composed roughly of 56 percent chipping logs, 23 percent stud logs, 21 percent post and poles, and a few peeler blocks.

Table 38 indicates there is a total of 485 thousand BDUS of chips and 33 thousand BDUS of sawdust for a grand total of 518 thousand BDUS of raw material readily available to manufacture pulp and paper. This is enough raw material to produce 298,000 tons of pulp and paper per year, far exceeding the needs of the maximum proposed plant expansion.

Table 38

Annual Logging Wood Waste Supply Readily Available from 9 of 11 National Forests that are Wholly or Partially Within Montana's Boundaries (1971 technology)

Raw Material Classification	Thousand Cords	Percent	Chips	Sawdust	Total
Post & Poles	154	20.7	0.0	0.0	0.0

(cont.)

Raw Material Classification	Thousand Cords	Percent	Chips	Sawdust	Total
Stud Logs	171	23.0	36.8	33.1	69.9
Peeler Blocks	2	0.3	0.6	0.0	0.6
Chips	416	56.0	447.3	0.0	447.3
	743	100.0	484.7	33.1	517.8

DEAD STANDING AND DOWN WOOD WASTE

The U.S. Forest Service reports 200.8 million cords of sound dead wood waste in the Bitterroot and Lolo National Forests contiguous to Missoula. These volumes do not include reserves classified as inaccessible or deferred areas. The Bitterroot National Forest accounts for 12.5 percent and the Lolo National Forest for 87.5 percent of the total 200.8 million cords, a wood waste accumulation that presents a delicate fuel management problem. The wood waste accumulation is composed of roughly 42 percent Lodgepole pine, 20 percent Alpine fir, 10 percent Douglas-fir, 10 percent larch, 10 percent Grand fir, 7 percent Engelmann spruce and 1 percent other species. The lodgepole specie classification includes some white bark pine and limber pine.

Access roads are adjacent to about 10 percent of the supply in the Bitterroot National Forest and between 15 to 20 percent of the inventory in the Lolo National Forest; therefore, it can be conservatively estimated that main access roads are in place to readily extract 30.1 million cords. It is estimated that this wood waste is composed of 21.5 million cords of chipping logs, 6.1 million cords of sawmill logs and 2.5 million cords of post and poles. Table 39 indicates that 24.4 million BDUS of chips and 1.2 million BDUS of sawdust is readily available for pulp and paper manufacturing. There is enough raw material available in the Bitterroot and Lolo National Forests' non-reserved (excluding deferred) area to produce 737,000 tons of pulp and paper per year for 20 years, although this accounts for less than 15 percent of the total dead standing and down wood waste accumulated in these two continguous forest areas.

Table 39

Total Dead Wood Waste Supply Readily Available from the Bitterroot and Lolo National Forests (1971 technology)

Raw Material Classification	Million Cords	Percent	Million BDUS Chips	Sawdust	Total
Post & Poles	2.5	8.3	0.0	0.0	0.0
Sawdust Logs	6.1	20.3	1.3	1.2	2.5
Chipping Logs	21.5	71.4	23.1		23.1
	30.1	100.0	24.4	1.2	25.6

SUMMARY OF WOOD WASTE SUPPLY

There is an ample supply of raw material for expansion. Table 39 indicates that there is a total supply in the Missoula area readily available to support the HW mill expansion. Markets for primary and secondary wood products and competition for raw material will ultimately determine the source of supply that will be tapped. Sawdust will continue to be used for fuel to generate energy by some companies, so not all sawdust in the summary analysis is available at this time. If the value structure changes, sawdust could be available for pulp. Wood waste from stand improvement thinnings is not considered in this proposal or future accumulation from natural causes.

E. Vegetation

The vegetation in the vicinity of the HW mill is dominated by the Douglas-fir, ninebark habitat-type as described by Daubenmire (54). Much Ponderosa pine is present at the lower elevations of the mountain slopes. Deciduous trees are found in the riparian communities along the Clark Fork River. Here cottonwoods and willows grow. EPA and the Air Pollution Control Association have ranked Douglas-fir and Ponderosa pine as relatively sensitive to SO_2 (55 , 56).

Sulfur dioxide damage on these trees appears variously as chlorosis, tip necrosis and banding, depending on the exposure length and concentration (56 , 57). The damage is attributed to the toxic sulfite ion which results from the oxidation of SO_2 once it enters the plant (58).

Sulfur damage to vegetation in the HW vicinity was first observed in 1963 by Gordon (59). The damage symptoms included necrosis on Ponderosa pine and Douglas-fir. These acute symptoms, though most frequent in areas west of the mill were found up to ten miles northwest and south of the mill. The damage on Douglas-fir increased drastically during the winter of 1973, at which time Clinton Carlson of the U.S. Forest Service initiated an in-depth study of the problem (60). The most severe sulfur type damage occurred quite close to the plant so his study was restricted to an area within three miles of the pulp mill and directly west. This area ranged in altitude from 3100 to 3800 feet. Sulfur emitted by HW is in the form of both reduced sulfur compounds and sulfur dioxide. The daily emissions include 20,376 lbs of reduced sulfur and 5000 lbs. of SO_2. In the winter of 1972-73, HW increased its sulfur emissions when it switched from burning natural gas to fuel oil. Company officials have indicated that this additional SO_2 possibly raised the levels emitted by the pulp mill to thresholds believed to be toxic to vegetation.

The symptoms observed on Douglas-fir by Carlson during the winter of 1973 included tip necrosis, banding, and needle casting. The damage syndrome appeared to progress from the inside of the crown outward and from the bottom of the tree upward. Aerial infrared photography of the region showed 1240 acres of Douglas-fir severely damaged, 1120 acres moderately damaged and 2840 acres lightly damaged.

Carlson's study of the area included establishment of 20 observation plots, on each of which two Douglas-fir and one Ponderosa pine were chosen for:

1. An assessment of extent damage.
2. Total sulfur analysis
3. Histological preparations.

The area was monitored for sulfur oxides using sulfation plates and bubbler samplers (61). Soil samples also were collected for analysis. Insect larvae were collected to determine if an infestation was present. The data from the HW vicinity was compared with data taken from control plots in Twin Creeks and Plains Montana which are 20 miles and 100 miles distant from HW, respectively.

Carlson's study implicated HW a cause of damage to the timber in the vicinity. With Douglas-fir, damage severity correlated with increasing sulfation rates. The excessive sulfur content of these severely damaged trees was significantly higher than that of trees growing on control plots. (Table 40). The sulfur content of tissue from each damage category (light, moderate, severe) differed significantly from control tissue. This sulfur content of Douglas-fir increased as the amount of oxidizable sulfur in the ambient air increased during July/August. This is worthy of note since the metabolic rate of these plants would be greatest during the summer. Trees are most susceptible to air pollution damage during their period of greatest metabolic activity. Total sulfur in Douglas-fir foliage decreased with increasing distance up to 3.5 miles from the pulp mill (Fig. 19), although this sulfur content was still considerably greater than that found in control plots.

Table 40

Statistical Significance of Means for Different Variables by Damage Class, Douglas-fir and Ponderosa Pine

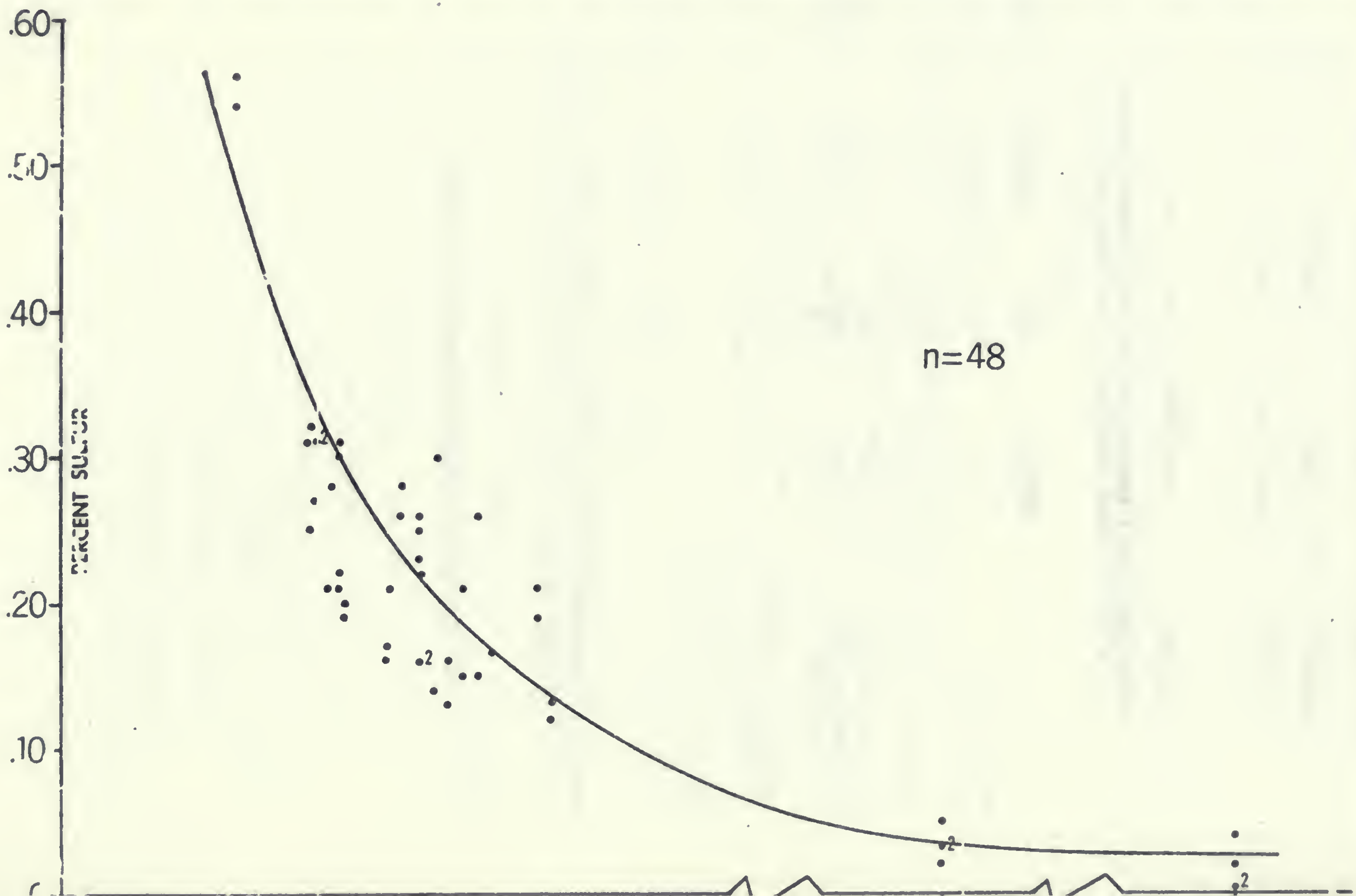
	Control	Light	Moderate	Severe
Needle Loss	2.81	2.63	2.41	2.20
Symptoms	.11	.20	.22	.36
Total Sulfur (DF)	.03[1]	.18	.22	.29
Total Sulfur (PP)	.01	.09	.12	.12
Sulfation Rate	.09	.96	1.17	1.52
Average Plot Distance from Mill		2.75	2.36	1.86
Average Plot Difference in Elevation		383	407	525

Means not underscored by the same line are significantly different at the 95 percent level.

---

[1] Percent sulfur based on the dry weight of the tissue.

FIGURE 19 Relationship of Percent Sulfur in Douglas-Fir to Distance From Pulp Mill, Miles



Histological work on Douglas-fir showed the typical syndrome of S damage (60). There was an indication of progressive breakdown of mesophyll parenchyma tissue beginning with granulation of chloroplasts, then plasmolysis and collapse of the cell. Hypertrophy of phloem tissue was observed in more severely damaged tissue. In the final stages the endodermis collapsed.

Little damage was found on Ponderosa pine growing with Douglas-fir within the study area. It has been documented that Ponderosa pine is not as sensitive to SO_2 as is Doublas-fir (62).

An entomologist, Mark D. McGregor, examined the insect larvae collected from the conifers sampled. The study indicated the presence of a negligible number of spruce budworm and tussock moths in the affected area, discounting these agents as significant contributors to the damage.

The U.S. Forest Service bubbler samples indicated SO_2 levels as high as 0.04 ppm for 1 hour during the period of the study. No monitoring of the area was conducted during the time when the damage is thought to have occurred as it is possible that this level was greatly exceeded at that time. This is plausible, considering the winter inversion frequency and presence of additional SO_2 from fuel oil combustion at the mill.

The Ecological Consulting Service of Helena conducted a study similar to Carlson's of damage to Douglas-fir and Ponderosa pine in the HW vicinity (63). The field investigation was designed "to be complementary to a study being done by the U.S. Forest Service." According to ECS, the study included wind direction, velocities, histology of Douglas-fir and Ponderosa pine needles, analysis of sulfur concentrations and estimation of percent needle loss.

The area was divided up into three altitudinal zones:

1. A low zone up to 3600 feet
2. An intermediate zone from 3600-4000 feet
3. A high zone from 4000 feet and above

The affected area where damage had been observed was divided into angular segments. Thirteen sites were chosen from these segments so as to complement the site locations of the U.S. Forest Service Study. In addition, data were collected from control sites proximal to those of U.S.F.S. in Plains.

At each site one Ponderosa pine and two Douglas-fir were chosen. Diameters were measured and cores were taken from each tree. Branches were collected from mid-crown. In addition, needles were separated and stored for sulfur analyses and histological preparations.

Results of this project showed that winds blew toward the study area from HW 34.4% of the days observed. There was a significant difference between the sulfur content of the study area needles and those of the control area. Also the older needles of Douglas-fir reflected a significantly greater amount of total sulfur than did the one-year-old needles. The levels of ambient sulfur compounds in the study area were significantly higher than that of the control area.

The study concluded that besides a significant buildup of sulfur in needles from the HW vicinity there was a higher percent loss of needles for Douglas-fir. Also, histological preparations indicated the presence of SO_2 type injury on Ponderosa pine tissue.

Both the Ecological Consulting Service and U.S. Forest Service findings furnish evidence that the HW paper and pulp mill has damaged trees west of the mill.

An air monitoring program was implemented by HW at the request of the Air Quality Bureau. Monitoring of the area indicated a peak concentration of 0.05 ppm SO_2 for a three hour period, and a peak H_2S level of 0.24 ppm. To date no violations of the state SO_2 standard have been monitored in the HW vicinity. Besides H_2S and SO_2, mercaptans are given off by the pulp mill. The situation seems to be one of frequent low level fumigations, with the impact primarily to the west of the mill in the heavily forested area.

No experimentation results of consequence are available on the effects of H_2S or mercaptans on vegetation either alone or in combination with SO_2. Therefore, it cannot be determined whether the damage to vegetation in the vicinity of HW is the result of SO_2 alone or in combination with other mill emissions.

SDHES has sampled vegetation growing in the vicinity of HW for sulfur content and damage symptoms. Needles were collected from Douglas-fir growing NW and SE of the mill. The sites were selected after taking into account the presence of sensitive species and the predominant wind patterns as indicated by data from the Rock Creek meteorological station. The trees were ranked for damage, and total sulfur analyses were made on 1973 needles using a Leco sulfur analyzer. The analyses indicated excessive S in Douglas-fir within three miles of the HW mill (Fig 20). The levels of sulfur drop off rapidly as does the damage severity with distance from the Mill (Fig. 21). Sulfur damage symptoms, tip necrosis, banding, chlorosis and needle casting, were observed on Douglas-fir up to 7 miles northwest of the mill. Where severe, the damage progressed from the inside outward and from the bottom of the tree upward. Chlorosis was the prevalent symptom on the damaged trees beyond five miles from the mill. These findings agree well with those of Carlson and Gordon.

The type of damage syndrome noted in Douglas-fir forests adjacent to the HW mill is further noted in other reports in the literature. A similar syndrome was documented by Scheffer and Hedgecock (62). The symptom appearance, symptom development, age of the sensitive tissue, species sensitivity and damage distribution which they reported in their smelter study all correlate with the findings of Carlson, Gordon, ECS and the SDHES concerning sulfur damage to trees in the vicinity of HW.

HW has said that even with the proposed expansion SO_2 emissions will not exceed the present 5000 lbs/day. There is evidence of chronic sulfur injury to plants occurring in the Douglas-fir forests immediately west of the mill even at this emission rate. During the winter of 1973 when it appears the

FIG. 20 Sulfur content (% dry wt) in Douglas-fir 1973 needles/miles from Hoerner Waldorf pulp mill

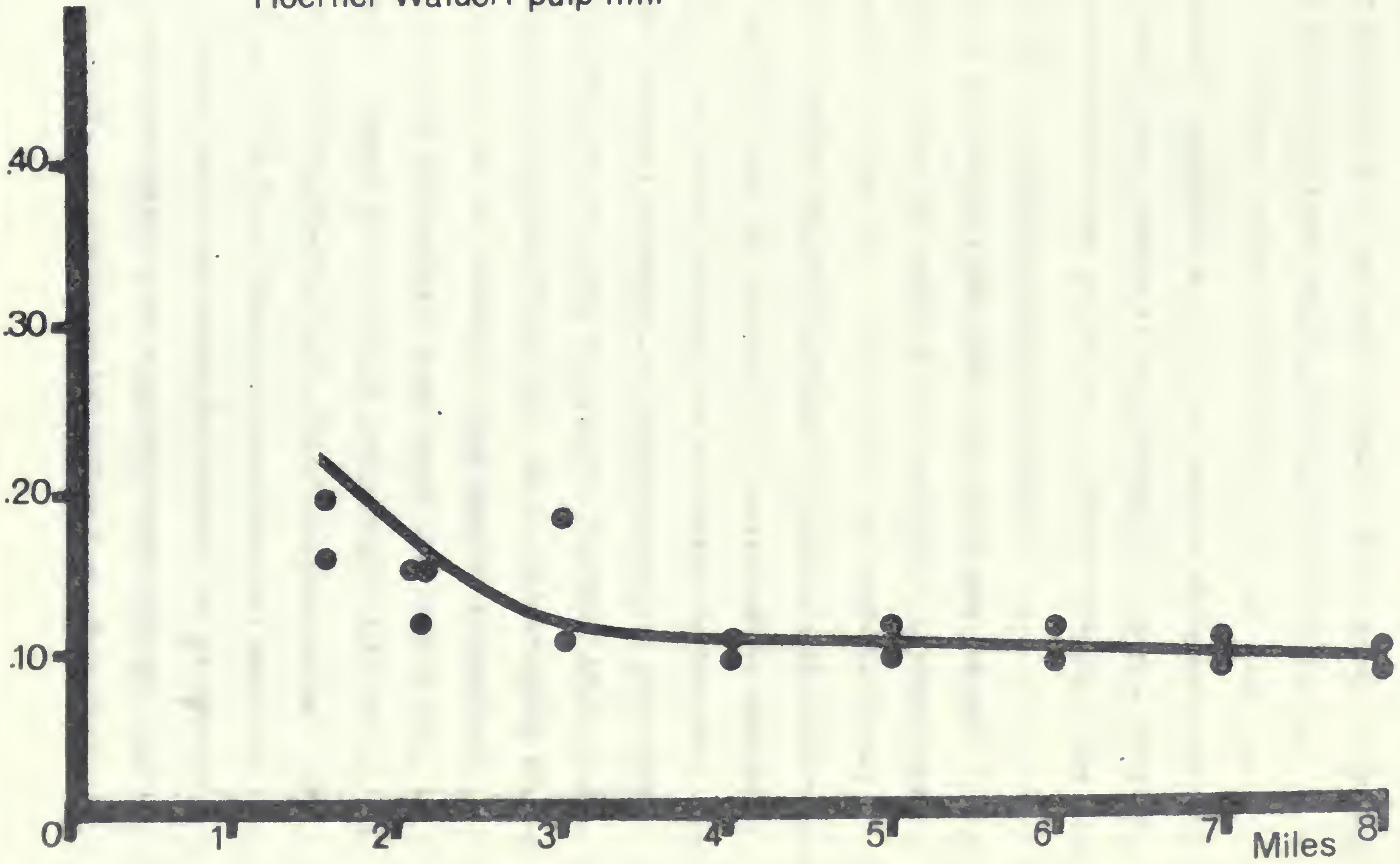
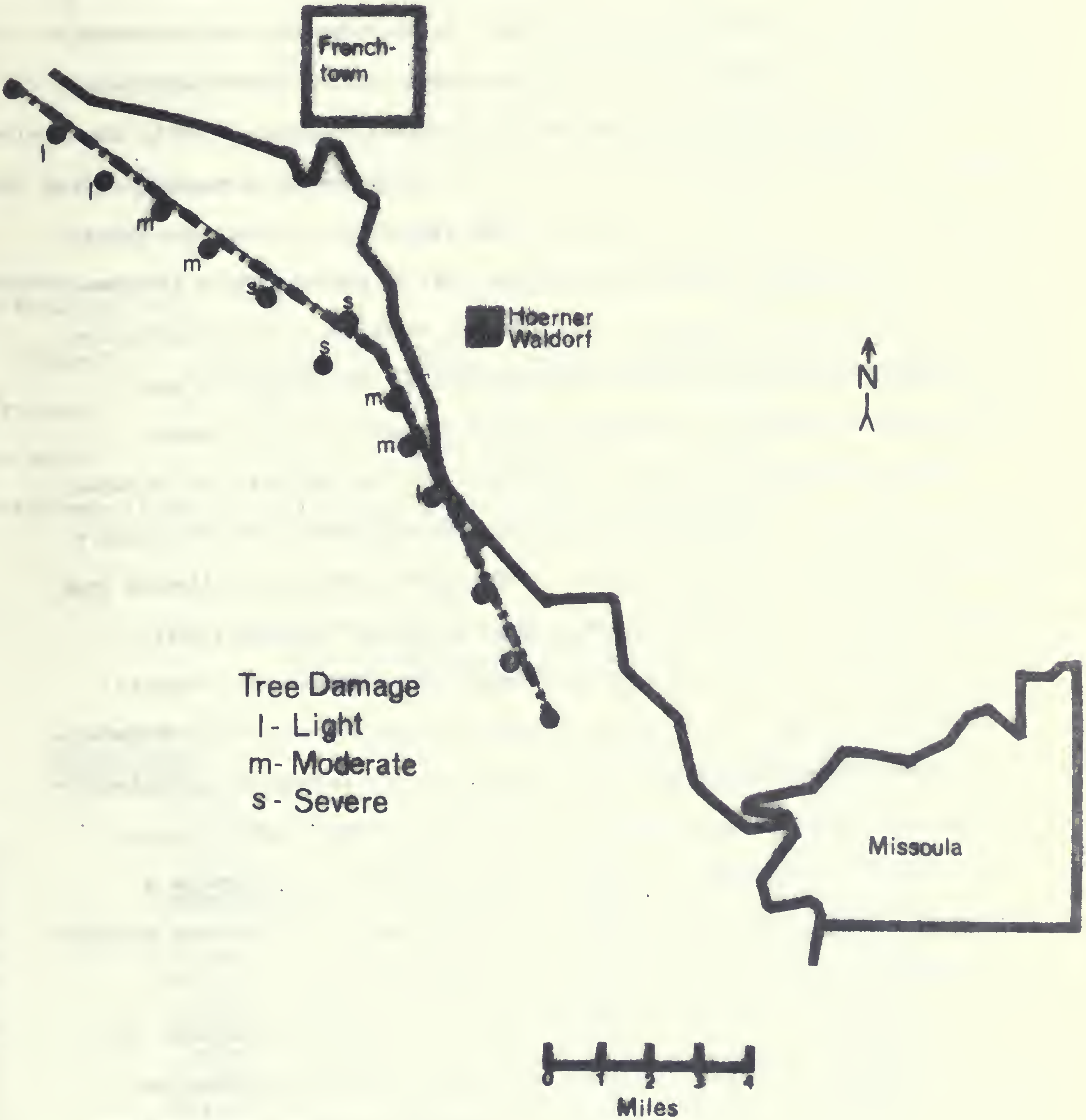


FIG. 21 Location of SDHES vegetation sampling sites



acute damage occurred, the emission rate may have been much greater than 5000 lbs/day of SO_2 according to the company officials.

Dr. Cokelet in his section of the "Environmental Impact Statement" for the proposed HW expansion (1973) has indicated that the highest levels of SO_2 would be expected during the winter months. He maintains that due to dormancy the trees would be resistant to the SO_2 emissions. Carlson (1974) attributed the damage to Douglas-fir as having occurred during the winter of 1973. The warm chinook conditions which occur during the winter months in Montana, differ considerably from the winter conditions found in Sudbury Ontario which Cokelet cites. The phenomenon of winter injury (64 , 65) to conifers which is prevalent in the northwest chinook zone results from increased evapo-transpiration and increased metabolism during warm winter spells. In Montana the warm chinooks induce metabolism, and make conifers susceptible to SO_2 damage.

Lichens reportedly are quite sensitive to SO_2 (66 , 67, 68), so in August 1974, the AQB made a study to assess whether the pollution in the HW vicinity was harming nearby lichen communities. Samples of lichens were collected from Ponderosa pine and Douglas-fir trees in the vicinity of Hoerner-Waldorf, Plains, Clearwater Junction and Pattee Canyon. These sites were chosen to correlate with studies by the Forest Service, The Ecological Consulting Service, and the University of Montana. A 6 cm long branch tip portion at approximately 2 meter height from ground surface was taken from randomly selected trees along transect. Following collection, samples containing *Alectoria sp* a reportedly S sensitive lichen (Ferry, Hawksworth, Baddeley, 1973) were selected for weighing. Results are included in Tables 41, 42, and 43 .

The weights of the lichens were subjected to statistical analyses. It was found that the weight of Alectoria specimens from the HW vicinity was significantly less than that of control specimens from Pattee Canyon, Plains and Clearwater Junction. Weight differences due to distinct climate, slope aspect, or forest habitat type can be ruled out since these factors were taken into account in choosing the sampling sites. The logical conclusion is that emissions from HW are inhibiting the growth of Alectoria sp in its natural habitat. The frequency of Alectoria occurrence in the Hoerner-Waldorf vicinity also was less than in the control areas. While Alectoria sp was found growing on 62% of the sampled trees in Plains and Clearwater Junction, and 100% of the sampled trees in Pattee Canyon, the lichen was found only in 42% of sampled trees in the Hoerner-Waldorf vicinity.

TABLE 41

Frequency and weight of Alectoria sp./6 cm branch tip Portion of Douglas fir and Ponderosa Pine

Alectoria	HW vicinity	Pattee Canyon	Plains and Clearwater Jct.
% Frequency	42	100	62
Mean Wgt.*	0.3609 gm	0.8754 gm	0.9453 gm

* Differences in mean weights showed high statistical significance

TABLE 42

WEIGHT OF ALECTORIA SAMPLES COLLECTED
FROM 6 CM BRANCH TIPS ON POND
PINE AND DOUGLAS FIR

Control Pattee Canyon		Hoerner-Waldorf Vicinity	
#	Weight	#	Weight
321	1.3205	355	0.3791
322	1.1891	356	0.6846
323	0.9136	358	0.3800
324	0.6766	359	0.2216
325	0.1638	361	0.3021
326	0.8153	362	0.1957
327	0.4659	364	0.6093
328	1.4068	365	0.4874
329	1.0950	367	0.2168
330	0.4794	368	0.2965
331	0.3304	370	0.1423
332	1.0670	371	0.3445
333	0.3354	373	0.3622
334	1.0456	374	0.2586
335	0.9456	376	0.1531
336	1.7565	377	0.3490
X = 0.8754 gm		X = 0.3364 gm	

TABLE 43

WEIGHT OF ALECTORIA SAMPLES COLLECTED FROM 6 CM BRANCH TIPS ON POND. PINE AND DOUGLAS-FIR

Control (Plains + Clearwater Jct.)			Hoerner-Waldorf Vicinity	
Plains	#	Weight	#	Weight
	304	0.6464	354	0.7702
	305	0.1684	355	0.3791
	306	1.5767	356	0.6846
	307	1.4097	357	0.2547
	308	3.6608	358	0.3800
	309	2.0945	359	0.2216
	310	1.1716	360	0.3244
	311	1.1337	361	0.3021
	313	0.3945	362	0.1957
	314	0.4252	363	0.2991
	316	0.5034	364	0.6093
	317	0.6745	365	0.4374
	318	0.3647	366	0.3061
	319	0.6052	367	0.2168
Clear. J.	338	1.6541	368	0.2965
	341	0.4418	369	0.3998
	342	0.4376	370	0.1423
	343	0.4842	371	0.3445
	344	1.2934	372	0.4077
	345	1.0414	373	0.3622
	346	0.3304	374	0.2586
	347	0.3780	375	0.1638
	349	0.4640	376	0.1531
	350	0.7084	377	0.3490
	351	0.7367	378	0.5791
	352	0.4668	379	0.5858

$\bar{X}$ = 0.9453 gm

$\bar{X}$ = 0.3609 gm

Richard P. Sheridan in his studies in the Missoula vicinity concludes there is a reduction in the biomass of lichens in areas fumigated by HW. These lichens also appear to have an elevated total sulfur content. (69) The sensitivity of lichens to SO_2 has been described in the literature (66 ,67 ,68).

Conclusion: Results from studies in the vicinity of Hoerner-Waldorf offer both repeatable and reproducible evidence of S damage to vegetation.

This evidence of sulfur damage to vegetation in the vicinity of HW has come from several sources: the U.S. Forest Service, Ecological Consulting Service, the Botany Department of the University of Montana, and the AQB. These sources indicate that:

1. SO_2 sensitive plants are present in the HW vicinity.
2. SO_2 type injury is visible on these plants as both acute and chronic damage.
3. SO_2 type damage and abnormalities are present in the tissues of these plants.
4. Excessive S has been accumulated by the plants.
5. The damage is not of the type associated with pathogenic fungi or insects.
6. A source of potentially hazardous SO_2 is present.

The damage to vegetation in the vicinity of Hoerner-Waldorf is continuing at the present time. The damage appears to be chronic; with the Douglas-fir exhibiting premature needle casting and chlorosis on the new growth. It cannot necessarily be concluded however, that this damage resulted from sulfur emissions solely in the form of SO_2. Monitoring in the area has shown that the SO_2 levels are lower than those which have been associated with vegetation injury (EPA, 1973) (55). Further monitoring for SO_2 and other pollutants throughout the area west of the pulp mill affected by the HW fumes should be conducted.

Excessive H_2S and mercaptans are emitted by HW in addition to sulfur oxides. These H_2S concentrations from the ponds and stacks greatly exceed the SO_2 emissions. Where experimentation has been conducted with H_2S alone, little injury occurred to even the most sensitive plants using concentrations as high as 40 ppm (56). However, synergistic reactions between different pollutants are known to result in damage to vegetation at threshold levels lower than that of single pollutants.

It is possible that the damage occurring to vegetation resulted from these other HW emissions in combination with SO_2. Perhaps current experimentation being conducted by the U.S. Forest Service in Missoula will clarify this. Certainly, the increase of emissions from the pulp mill expansion will result in an increase of this already excessive damage to the plant communities growing in the vicinity. Since the damage to these communities is occurring at levels of pollutants below that which has been considered threshold for sensitive species, further monitoring and research should be conducted to determine levels of tolerance for the plant communities.

IV. ACTIONS AVAILABLE TO SDHES

A. Statutory Authority

The statute (69-3911) provides that upon acceptance of a permit application, SDHES must decide whether and/or in what form the permit will issue. There are three available options: issue the permit as requested, deny the permit, or issue a conditional or modified permit.

By the authority of the statute, the Board of Health adopted a regulation regarding permits establishing the practices and procedures to be followed. Subsection 12 of regulation 16-2.14(1)-S1400 specifies the criteria for a decision on a permit application as follows:

> The director shall deny an authority to construct, or permit to operate or use, except as provided in this regulation, if the applicant does not show that every article, machine, equipment or other contrivance, the use of which may cause the issuance of contaminants, or the use of which may eliminate or reduce or control the issuance of air contaminants, is so designed, controlled, or equipped with such air pollution control equipment, that it may be expected to operate without emitting air contaminants in violation of standards and regulations formulated under authority of the Clean Air Act of Montana.

The Board realized that situations would arise wherein it could not definitively be established whether compliance would be attained and it provided for such occasions as follows:

> The director may issue an authority to construct or a permit to operate or use, subject to conditions which will bring the operation of any article, machine, equipment or other contrivance within the standards of this regulation, in which case the conditions shall be specified in writing. Commencing work under such an authority to construct or operation under such a permit to operate shall be deemed acceptance of all the conditions so specified. The director shall issue an authority to construct or a permit to operate with revised conditions upon receipt of a new application, if the applicant demonstrates that the article, machine, equipment or other contrivance can operate within the standards of this regulation under the revised conditions.

The conditions to be attached to the permit are set forth later in this statement.

B. Alternatives Available to HW

The most obvious alternative available to the company is to agree to install further air pollution control equipment, beyond what was proposed in the permit application. Because of the variety of types of sources of air pollution in the pulp and paper industry, control of the resulting emissions and the evaluations of "state of the art" are considerably more complex than for other industrial facilities where the control methods are fairly well established. For example, control of reduced sulfur emissions from the recovery boiler is entirely different from control of reduced sulfur emissions from contaminated condensates. Because of the nature of the plant, the following section will deal with each individual source of air emission and the necessary air pollution controls for the various pollutants emitted rather than discussing the various pollutants topically as in the previous sections.

Recovery Boiler

The most conspicuous air pollution source is the recovery furnace. The air emissions are sulfur dioxide, reduced sulfur--primarily H_2S--and particulate emissions--primarily sodium sulfate. Recent trends in the industry have indicated the use of internal rather than external controls for the gaseous emission. An internal control is the use of some process or design which prevents the generation of the gaseous emission, rather than installing some type of collecting device to remove the compounds from the flue gases. In the Kraft industry, for example, the emissions of sulfur dioxide are regulated by controlling furnace operating and design parameters rather than by the use of external SO_2 controls.

At present, there are Kraft recovery boilers operating in the United States with reduced sulfur emissions of less that 1 ppm TRS in the flue gas (70). HW's present proposal indicates an operation resulting in a daily average of five ppm TRS concentration in the flue gas. It is conceivable that HW could reduce its emission levels to those found at other mills if it knew how, but the mechanisms used by other mills to reduce emissions are not clearly understood by anyone. Generally, the reductions have been obtained by modifications to such variables as black liquor feed temperature, nozzle angle, quantities and locations and introduction of combustion air, and regulation of the amount of excess air. Reducing the TRS emissions requires a trial and error process to determine what set of conditions will result in the lowest emission.

Current state standards allow the emission of 17.5 ppm TRS in the flue gas. HW is doing considerably better than this. Presently the total daily quantities of H_2S emitted from the recovery furnaces are almost insignificant when compared to other sources of emission at the mill. TRS emissions from the proposed expansion would not be significant either.

Sulfur dioxide emissions reflect a different situation. Until conversion of recovery furnaces to the low odor process, SO_2 emissions from Kraft mills were almost nil. However, the operation of the low-odor furnaces has resulted in some substantial emissions of SO_2. In fact, EPA reports (71) that SO_2 emission from furnaces in various mills will range from 0.1 to 10 lbs/TADP with an average of about 4 lbs/TADP. HW has committed itself to maintaining an SO_2 emission of less than 5,000 lbs/day. At current production rates, this is approximately 4.3 lbs/TADP--somewhat higher than the industry average. As proposed for the expanded mill, the total emission of SO_2 from recovery furnaces would not increase but would remain at 5,000 lbs/day although the pounds of SO_2 per ton of pulp would be reduced to 2.7. EPA said the best technology appears to be about 0.1 lbs/ton of air dried pulp produced. There are a number of ill-defined operating variables that can affect SO_2 emissions but green liquor sulfidity has fairly well-demonstrated effects on the emissions. It appears that once the green liquor sulfidity is reduced below 27% very minimal reductions in SO_2 occur. At this level, HW, should it so choose, could limit sulfur dioxide emissions even with the expanded mill to about 2000 lbs/day or slightly over 1 lb SO_2/TADP. The other possible sources of SO_2 in the mill will be discussed later.

The choice of a technique for controlling particulate emission from the recovery boilers is not as clear-cut as the gaseous emission control. HW's current and proposed choice of particulate control device is the electrostatic precipitator. The precipitator type chosen is among the most efficient currently available. Throughout the Kraft industry, the electrostatic precipitator is considered the "state of the art" in particulate removal although there is controversy as to whether a precipitator alone can achieve adequate results.

EPA said the best control achievable with a precipitator would result in the emission of .01 to .04 GR/DSCF (Dry standard cubic foot) corresponding to 0.5 to 2.0 lbs/ton. HW's emissions average slightly less than .04 grains/DSCF on No. 4 (1.3 #/ton) and 0.066 GR/DSCF on No. 3 (2.2 #/ton). The expanded mill would add the further emissions of the No. 2 furnace at 1.4 lbs/ton (0.031 GR/DSCF). Some Kraft mills have equipped their recovery furnaces with a wet scrubber following the precipitator. Apparently these scrubbers were installed because the precipitator failed to reduce emissions to the desired levels. It thus appears that the use of a wet scrubber after a precipitator is feasible at least from engineering design and operational standpoints. Further, EPA said, "In some instances, a low- or medium-energy scrubber is installed after the precipitator. Such scrubbers can be effective because of their agglomerating effect." (4) "Where no flue gas direct contact evaporator is used, particulate emission control in current designs is by precipitators alone, although nothing precludes the use of secondary scrubbers." (4)

The extent of particulate reduction that could be achieved by such a scrubber on a precipitator like HW's is uncertain. In conventional wet scrubber design, the collection or removal efficiency is directly proportional to energy input and pressure drop, so substantial energy investment is necessary to achieve high efficiency. Further, particle size affects collection efficiencies and energy requirements significantly. HW's current emissions generally are very small in size, less than two microns (μ). Energy demands for removal of small particles are generally higher than equally efficient removal of larger particles. It thus appears that additional particulate removal equipment could be installed following HW's electrostatic precipitators but the cost and collection efficiencies remain in question. Perhaps, however, some evidence can be obtained by inspecting an extreme case of particulate control by wet scrubbers. For example, various plants in the aluminum industry have installed wet scrubbers to control fugitive emissions. One plant of the same basic type as Anaconda Aluminum in Columbia Falls employs a very simple spray scrubber. The average inlet loading during some EPA tests (72) was 0.00321 GR/DSCF, less than one-tenth of HW's precipitator outlet. The average outlet for these tests was 0.0011$_3$ GR/DSCF or an efficiency of 65%. During one test, the scrubber achieved 79% efficiency (inlet-0.00265 GR/DSCF, outlet-0.00057 GR/DSCF). The average particle size (50% less than given size) appears to range from 1-2.5 μ.

Boilers

SO_2 emissions are of most concern from the existing power boilers and the No. 1 recovery furnace (to be converted to a power boiler) when firing oil as fuel. In these cases, the sulfur contained in the fuel is emitted from the furnace or boiler as SO_2. HW has said it will install a sulfur dioxide scrubber on the No. 1 furnace. Further, it will put in a power boiler capable of burning natural gas, oil, or hogged fuel. With this configuration, HW can limit sulfur dioxide emissions during periods of natural gas curtailment. Otherwise, oil would be burned, as now, in power boilers with no SO_2 control when natural gas was curtailed. In the expanded plant, HW could burn oil in the converted No. 1 with the SO_2 scrubber and burn wood waste in the triple fuel boiler to supply all the mill's steam requirements without any uncontrolled combustion of sulfur-containing fuel.

Control of the emissions from smelt dissolving tank vents is not quite as complex. TRS emissions are insignificant (about 4 lbs/day) and sulfur dioxide emissions are non-existent. Only particulate control is required for these units. Currently Hoerner-Waldorf has equipped the dissolving tank for the No. 4 furnace with a packed column scrubber and that for the No. 3 with a demister pad. The demister pad is a rather inefficient means of particulate control in this case and the column does not seem to be achieving the best performance it could. Currently the smelt tank for the No. 3 furnace emits 870 lbs/day of particulate matter and is in violation of regulations which allow 508 #/day. Emissions from No. 4 are 365 #/day. On a lbs/ton basis, No. 3 and 4 emit respectively 1.9 and 0.5. The unit for the proposed No. 2 dissolving tank would be 120 lbs/day or 0.4 lbs/ton. The EPA said (71) the best technology is 0.1 lbs/ton. For the expanded mill, this would result in the total emission of 185 lbs/day instead of the proposed 1340. HW has indicated it would be agreeable to replacing the demister pads on the No. 3 tank vent with a packed column, reducing that emission from 870 lbs/day to 164 lbs/day. This would bring the total particulate emission from the smelt tanks down to 634 lbs/day. This is still considerably higher than what EPA considers to be the "state of the art."

LIME KILNS

The lime kilns are another major source of emissions in the pulp mill and control is required for both reduced sulfur compounds and particulate matter. HW currently has three lime kilns with particulate emission of 0.3, 0.83, and 0.35 lbs/TADP. The proposed expansion would add another kiln with emissions of 320 lbs/day or 0.32 lbs/ton. EPA said that best available technology for control of particulate from lime kilns ranges from 0.2 to 0.8 lbs/TADP. Equivalent grain loadings are 0.03 to 0.1 gr/dscf. HW's lime kilns currently are emitting, respectively, 0.048, 0.131, and 0.055 gr/dscf. The proposed No. 4 would operate with a grain loading of 0.055. The venturi scrubbers now employed by HW generally are thought to be among the better controls available. However, HW has considered equipping the No. 4 kiln with an adjustable throat venturi scrubber, which would be slightly more efficient than the non-adjustable type. If the more efficient device were installed, the No. 4 kiln would emit 220 lbs/day of particulate rather than 320. It is not at all inconceivable that the existing kilns could be equipped with similar type venturis and that the No. 2 kiln's emissions could be reduced equivalent to those of No. 1, as both kilns are the same size and operate in roughly the same manner. In this case, the following emission would result.

	Particulate emission lbs/day	Emission lbs/ton
No. 1	60	0.2
No. 2	60	0.2
No. 3	120	0.23
No. 4	220	0.22

It appears technically feasible to reduce the emission from lime kilns. Again the remaining question is one of cost.

Lime kilns also emit reduced sulfur compounds for a couple of reasons. The water in the slurry from the causticizing tanks and the mud washers contains dissolved sulfides. As the slurry is processed through the kiln, the water is driven off and the sulfides are easily converted to hydrogen sulfide by reaction with CO_2 if the operating conditions are favorable. Also, if the wash water used in the wet scrubbers is contaminated from another source in the mill, dissolved TRS compounds may be liberated when when air contacts the water in the scrubbers. The lime kilns are used as incinerators for gaseous reduced sulfur compounds from various sources in the mill. If combustion is incomplete, emission of odors may result. Currently the three kilns emit about 234 lbs/day of reduced sulfurs or 62, 62, and 110 lbs/day from kilns 1, 2, and 3. Corresponding lbs/ton figures at 0.2. The additional kiln would emit 134 lbs/day of 0.13 lbs/ton. HW has now proposed the use of caustic scrubbing in the kiln scrubbers to reduce TRS emissions. This would bring the TRS emissions down from approximately 50 ppm in the flue gas to 20 ppm with total emissions as follows:

Kiln #	Emission #/day	Emission #/ton
1	25	0.083
2	25	0.083
3	44	0.085
4	51	0.085

The remainder of air pollution sources in the mill are fairly simple to control and the emissions are not those that are of most concern in the case at hand. The hogged fuel boilers, both existing and proposed, will be equipped with wet scrubbers which reduce emissions as low as can be expected. The miscellaneous chemical unloading and handling facilities are equipped with baghouses which keep the emissions at an absolute minimum if they are maintained properly. The washer hood vents are an uncontrolled source of particulate matter and TRS, emitting about 984 lbs/day. Under the terms of the expansion as proposed, these emissions would be reduced to 317. However, HW has agreed further to duct these gases to a combustion chamber, burning the wood fiber particulate and reducing the emission to essentially 0. For reduced sulfur compounds, the emission reduction is similar. Current emissions are about 91 lbs/day of TRS as H_2S. This would increase to 146 as the expansion is proposed, but incineration in a boiler could reduce TRS to 0. The foul condensates are a conglomeration of liquid wastes removed from the mill to the liquid effluent system. They contain considerable amounts of dissolved or entrained odorous gases. As the various sewers go through the mill and pick up effluent streams, ph changes and aeration in open sewers liberate significant quantities of reduced sulfur compounds. HW estimates that about 1600 lbs/day of odorous compounds from the mill escape to the air from the sewers in the mill with another 1200 lbs/day liberated from the pond system. As the expansion is proposed, HW would air-strip these contaminated condensate streams, removing the reduced sulfur compounds from the liquid stream to a gas or air stream. The air stream would then be vented to the lime kilns for incineration of the TRS compounds. This air-stripping is expected to be at least 90% efficient for removal of TRS. Current emissions of 2800 lbs. are forecast to increase with the expansion to 4510 if there were no stripping, but the stripping would reduce these to 451. The 90% stripping efficiency is a minimum figure and the SDHES strongly suspects that better efficiency can be achieved, perhaps 95 or 97%. The stripping efficiency is dependent on the compound being stripped. HW data (17) indicates the composition and stripping efficiencies of the gas stream as follows:

Compound	#/day Inlet Expanded Mill)	Stripping Efficiency %	#/day Emission (Expanded Mill)
H_2S	3192	93	227
CH_3SH	959	86	137
$(CH_3)_2S$	220	78	48
$(CH_3)_2S_2$	139	72	39
	4510	90*	451

* Overall average.

EPA said that airstripping with subsequent incineration is consistent with best available control technology for these foul condensates.

COST OF AIR POLLUTION CONTROL ALTERNATIVES

Discussing the costs of various control techniques and apparatus for any given pulp mill is fraught with hazards, as the costs of similar systems applied to other mills may vary greatly, depending on a vast number of variables in the environment and the physical and operational characteristics of the mills.

Probably the most common cost assessment methods for comparative purposes are those which result in cost data on a production basis of some sort. The figures include dollars per daily or annual capacity ton based on total capital costs divided by the production capacity of the facilities. The units may be dollars per ton of pulp produced, based on the annualized capital costs plus operation, maintenance, and depreciation, divided by the annual production of pulp. Perhaps these methods are not totally valid either as they do not account for such things as availability of capital for projects, or mill profitability, but they very likely are the best comparative methods available.

Probably the most desirable method annualizes costs and relates them to production of pulp. On this basis, one can compare the cost of the air pollution control to the selling price of the product or production costs. However, evaluation on this basis requires the acquisition of considerable data on operating and maintenance costs, depreciation, and interest rates. This information can be difficult to obtain unless the process or device has been installed and operated at enough locations long enough to develop the data. Capital cost data is less difficult to obtain. Where available, both capital costs and annualized costs are presented. Even if general or specific data is available, its validity is open to question.

Vandegrift et. al., reported costs for the control of fine particles by various control devices. (73) The following table is extracted from those data. It is based on wet scrubbers with 75% collection efficiency and calculated for various size scrubbers. The details on the type of scrubber are unknown.

Table 44

Cost of Adding Scrubbers to Recovery Furnace

Furnace	Equivalent Pulp Production TPD	Flow Volume ACFM	Installed Cost		Annualized Cost	
			Total	$/Annual Capacity Ton	$/yr	$/ton pulp
2	300	180,000	57,000	0.54	43,000	0.41
3	465	221,300	71,000	0.43	51,000	0.31
4	1000	410,000	115,000	0.32	94,500	0.27

The above data relate to the recovery furnaces in terms of the addition of a wet scrubber to remove 75% of the existing particulate emission. The dollars per ton figures have been calculated from equivalent production capacity of the recovery boilers being for #2, 300 T/day; #3, 465 T/day; #4, 1,000 T/day. Some data from other sources indicate these cost figures may be too low.

For control of the lime kilns, the data that follows has been taken from Industrial Gas Cleaning Institute (IGCI) data from the September, 1974, Journal of the Air Pollution Control Association. (74) The basic for the data is the use of a high energy wet scrubber under the following conditions:

Inlet loading - 3.60 GR/DSCF
Outlet loading - 0.01 GR/DSCF
Pressure Drop - 40" w. c.
Inlet temperature - 350°F
Outlet temperature - 168°F
Application - Rotary Lime sludge kiln, Kraft Paper Mill

These design parameters appear similar to those in HW's lime kilns. The collection efficiency on the scrubbers is 99.7+%. The costs data for the various size scrubbers was taken from IGCI data for two different sizes and extrapolated using a capital scale factor of .5 for the larger units and assuming no economy of scale for the smaller ones.

Table 45

Cost of High-Energy Wet Scrubbers on Lime Kilns

Kiln #	Equivalent pulp capacity (TPD)	Flow Volume ACFM	Installed Cost		$/yr	$/ton Pulp
			Total Cost	$/capacity Ton		
1	300	21,111	66,000	0.62	22,500	0.21
2	300	23,373	73,000	0.69	25,000	0.23
3	520	32,843	95,000	0.52	35,000	0.19
4	604	60,000	129,000	0.61	65,000	0.30

All of the above data relate to the HW expanded mill which would have the production capacity for 617,500 tons of Kraft pulp per year according to the individual unit capacities above. For the schematic proposed here, total installed costs would be just over $600,000 with annual maintenance, operation, interest, and other costs totaling approximately $336,100 per year. On a dollars per ton basis, capital costs would be 98¢ per annual capacity ton, with annualized costs 54¢ per ton of pulp produced. The scrubber data for the lime kilns seem to be valid and reasonable, although the data for the addition of scrubbers to the recovery furnaces is somewhat questionable. The addition of a control device following the high efficiency electrostatic precipitator is not commonplace and the necessary design parameters presently are unavailable. Without these parameters, it is very difficult to project a configuration for the scrubber, and therefore, the costs are uncertain. A situation might arise where control of these emissions would require a high energy scrubber which normally is associated with high collection efficiency. Due to the particle size and grain loading, the resulting collection efficiency might be quite low, and it therefore is questionable whether the data based on the efficiency curves would be applicable.

Another suggestion for the possible control of fine particulate in the recovery furnaces is the mist-soluble solids eliminator, the best known of which is the Brink Mist Eliminator. One such unit has been installed after the absorber towers in a sulfite pulp mill, which is not the same process used by HW, but indicates what can be done and the cost of doing so. This unit was installed for a total cost of $1.1 million with basic hardware costs between $300,000 and $350,000. The total cost was 3 to 4 times the hardware cost. This unit was treating about 21,000 DSCFM. HW would require treatment of approximately 320,000 DSCFM, or 15 times as much. The efficiency on this unit was about 98% and the outlet grain loading ranged from 0.0035 to 0.0063 gr/dscf. The above information does not purport to show specific costs for additional pollution control above and beyond what HW has proposed, but only the orders of magnitude involved and the variability of the cost data. It does show, however, that additional controls added at a reasonable cost could achieve further particulate reductions.

V. ENVIRONMENTAL IMPACTS OF ACTIONS AVAILABLE TO THE DEPARTMENT

A. If the Permit were Denied

If the construction permit were denied, there nevertheless would be a decline in emissions from the ponds as a result of the aeration system in the ponds. The extent to which emissions would be reduced is uncertain, but it appears the reduction would be at least 90 percent of the minimum of 17,000 pounds of H_2S now coming from the ponds daily.

Inasmuch as the impacts of the pond emissions are not known, it is not possible to predict what effects would result from the planned reduction of the emissions. Considering the low odor threshold of H_2S, methyl mercaptan, and some of the other odorous gases coming from the ponds, it is likely that the odor problem would persist, although with fewer and less intense episodes. A change in odor would be evident, as hydrogen sulfide odor was replaced by the odor of mercaptan compounds. Restricted visibility within the Missoula Valley would remain unchanged since many small particles would still be emitted into the valley air.

The various impacts believed to result from air emissions are discussed earlier in this statement.

Existing environmental impacts from liquid discharges are as follows:

1. There is some reduction of dissolved oxygen by the discharge of wastewater into the Clark Fork River during the spring runoff. Dissolved oxygen in the river during discharge is maintained above 7.0 mg/l; however, any reduction of DO from that naturally occurring may be detrimental to some forms of aquatic life.

2. Color standards are presently exceeded during the direct discharge of effluent to the Clark Fork River. During low flows in the river, there

is noticeable color along the river bank near the ponds and immediately below the ponds.

3. There is a taste and odor in fish flesh during direct effluent discharge to the river. This taste and odor problem also may occur in the immediate vicinity of the mill during periods of low stream flow.

4. Foaming may be a problem in the river downstream from the plant, particularly below dams during periods of high stream flow and direct effluent discharge to the river.

5. Substantial odors are produced by the ponds.

6. There might be a threshold odor problem if water were taken from the river and treated for a domestic water supply.

7. About 745 acres of land have been removed from agricultural usage due to the ponding system.

8. The shallow aquifer underlying the effluent storage ponds contains considerable seepage water from the pond system. Pond wastes have also entered the deep aquifer in the vicinity of the plant. The quality of percolated wastewaters is significantly inferior to natural groundwater.

B. If the Permit were Granted as Requested

If the permit were granted as the company requested and the plant expanded emission of reduced sulfur compounds would decline and SO_2 emissions would not increase at the present levels, however, particulate including particulate sulfate emission would increase. Visibility would be decreased by increased concentrations of very small particulate in the air.

Impacts that would result from the liquid discharges of the expanded plant are as follows:

1. Discharge of wastes into the river will cause a small reduction of oxygen concentration in the river.

2. During low flows in the river, there will be noticeable color along river banks near the ponds and immediately below the ponds. Color due to mill effluent should not violate state water quality standards downstream from the mixing zone. If rapid infiltration disposal is used totally, total color entering the river will be greatly reduced as compared to use of direct discharge.

3. The potential for a taste and odor problem in a domestic water supply if taken from the Clark Fork River below the mill cannot be accurately assessed. Literature on taste and odor of fish flesh indicates that this parameter will not be a problem.

4. There will be odors associated with the sludge ponds.

5. Through in-plant reduction of chemical losses and biological treatment, foaming potential of the wastewaters should be decreased.

6. An additional area of up to 345 acres may be removed from agricultural use for effluent disposal.

7. The shallow aquifer underlying the effluent storage ponds will contain considerable seepage water from the pond system. Pond wastes will continue to enter the deep aquifer in the vicinity of the plant. The quality of percolated wastewaters is significantly inferior to natural groundwater. A larger volume of wastewater may be discharged to the groundwater. The possible lateral extent of groundwater alteration cannot accurately be predicted, but is thought to not extend significantly beyond the boundaries of the mill property.

VI. Response to Public Opinion

There has been no lack of public opinion on the proposed expansion. Immediately after the proposal to expand in 1973, environmentalists began expressing their concerns. On the opposite side, many others expressed varying degrees of support for the expansion, in the belief that it would broaden the economic base of the area and increase the income of the various writers.

Since issuance of the draft on June 17, 1974, this department has received approximately 140 individual written communications, of which about 70 percent opposed the expansion. The Missoula County Health Officer, Dr. Kit Johnson, initially advocated a two-year delay in the expansion. Many other physicians in Missoula and many members of the public supported Dr. Johnson's recommendation.

In his latest letter to this department, Dr. Johnson wrote that he thought it would be "reasonable" for SDHES to grant the permit, providing that certain conditions were met, as noted in Appendix E.

Following Dr. Johnson's latest letter, 52 Missoula physicians signed a letter to SDHES requesting a 2-year delay in the expansion, based on the need for more monitoring and research into the health effects of sulfates in the Missoula Valley. Medical opinion of this nature must be weighed heavily, as possible health effects lie at the heart of all concern with pollution control.

Other correspondence received following issuance of the draft dealt with many other topics in such detail that summarization for inclusion into this statement was not possible. The authors attempted in the body of this statement to deal with all criticisms, questions and queries received since publication of the draft.

All correspondence and testimony regarding the proposed expansion has been entered into the permanent record and may be viewed by anyone at the offices of the Environmental Sciences Division of SDHES.

VII. CONCLUSION

Following consideration of all public comments regarding the draft statement, and after reviewing all available information on the state-of-the-art in pulp and paper mill pollution controls, SDHES decided to grant the requested permit, if the company would agree in advance to several conditions. These conditions would minimize the adverse environmental impacts of expanding the mill while providing considerable opportunity for environmental and economic improvement.

Prior to issuance of any permit, SDHES will insist that HW submit a written agreement to these conditions. If no such agreement is obtained the permit will not issue. Generally the conditions that must be met are as follows:

1. That the company agree to pay to the SDHES a sum of money necessary to conduct a thorough and comprehensive study of the effects of sulfates on human health in the Missoula Valley. This study shall be completed by January 1, 1977. The SDHES agrees that the study will be conducted by the personnel of the department or by consultants approved by Hoerner-Waldorf. The amount of Hoerner-Waldorf's payment for the study shall be established prior to permit issuance. Based on the results of the study, the department shall adopt an appropriate sulfate emission limits for the facility including, if warranted, a prohibition against any increase in sulfate emissions from the current levels.

2. That the total particulate emissions from the mill site do not increase.

3. That Hoerner-Waldorf continue with an ambient monitoring program similar to the current one, with some expansion (addition of a 3rd gas chromatograph) and modifications as specified by the state for a period of no less than 3 years.

4. That Hoerner-Waldorf institute an emission reporting program subject to approval by the state.

5. That Hoerner-Waldorf institute a program, subject to approval by the state, for pilot plant studies relating to additional emission control of recovery boilers.

These conditions are thought necessary for the following reasons.

1. Health effects study:

There exists a fairly substantial body of evidence to suggest that sulfates in the air may adversely affect human health at the levels currently found in Missoula and possibly lower. SDHES would be remiss in its duty if it allowed emission of more sulfates, without further investigation of their effects on health. Further, a significant portion of the Missoula medical community believes that sulfates may be hazardous at current levels. Considerable study must be done to establish the risk levels. Further, there is evidence of the presence of acid sulfate aerosols which are implicated as a cause of adverse human health effects. Again the threshold damage levels are undefined, although a substantial body of scientific evidence points out the possible effects.

2. No increase in total particulates:

Currently the total suspended particulate levels in Missoula are barely below the federal primary ambient air quality standard and this level cannot be exceeded. It has been established that long term exposures to higher concentrations are health damaging. Although HW emissions apparently do not constitute a large portion of this total measured suspended particulate, there is no room for further increase. The high particulate levels are significant to other particulate sources in the area, which also will have to meet air quality criteria should they wish to expand or modify their operations.

3. Expanded monitoring program:

There still remain doubts both as to the efficiency of the pond aeration system in reducing odorous emissions and whether the pond emissions are responsible for the concentrations of reduced sulfur measured and smelled in the Missoula vicinity. Also unresolved are the effects of other odor control measures proposed by HW. The ambient monitoring program will be continued to determine the effect of the process changes and controls instituted by HW.

A gas chromatograph monitor should be placed near the population center of Missoula to help determine if there is a correlation between pollutant levels and health effects.

4. Emission testing and reporting:

HW has submitted emission data showing pollutant levels which the company believes are higher than those that actually exist. To clarify this situation, the AQB will research the problem further, testing and supervising testing of the various emission sources in the mill. This testing will allow a check of the emission data used for the basis of this decision and definitively establish the emission limits to be met by the expanded mill.

5. Pilot plant studies:

While additional air pollution control appears to be available for the recovery boilers, this condition should serve to definitively establish the feasibility (technical & economic) of additional emission control. It will further ensure that, should this added controls be deemed necessary, they will be added as soon as possible.

As additional conditions to the permit, the state will require some specific controls which HW already has indicated it could accomplish. These control measures are to include ducting of the washer hood vent gases to a combustion source, and subsequent incineration of the TRS and wood fiber particulate; replacement of the #3 dissolving tank scrubber to a packed column scrubber at least as efficient as that on the #4 vent; and as a minimum, equipping the #4 lime kiln with an adjustable-throat venturi scrubber.

It is the SDHES's firm belief that should HW accept these conditions and go ahead with the expansion, the area residents and the state as a whole would receive the environmental benefits of marked reduction in odorous emissions, [redacted] increased utilization of waste materials, and possibly some economic benefits to the area in reduced unemployment.

Should HW decline to accept the above conditions, the SDHES would deny the permit, on grounds that expansion of the mill without the controls deemed necessary could cause environmental impacts far outweighing any economic benefits.

REFERENCES

1. *Development Document for Proposed Effluent Limitations, Guidelines and New Source Performance Standards for the Unbleached Kraft and Semi-Chemical Pulp Segments of the Pulp, Paper and Paperboard Manufacturing Point Source Category*, EPA, 1974 (EPA 44/1-741025)

2. *Economic Analysis of Proposed Effluent Guidelines--Pulp, Paper and Paperboard Industry* (EPA 230/1-37-023) September 1, 1973

3. Shreve, R. Norris, *Chemical Process Industries*, McGraw-Hill, 1967

4. *Atmospheric Emissions from the Pulp and Paper Manufacturing Industry*, U.S. EPA, Doc. No. EPA - 450/1-73-002, September, 1973

5. *Compilation of Air Pollutant Emission Factors*, U.S. EPA, AP-42, April 1973

6. Hoerner-Waldorf Corporation *Revised Construction Permit Application*, to the Air Quality Bureau, April 1974

7. Letter from Roy Countryman, HW to John Green, EPA, September 17, 1973

8. Owen, G.L. submittal to AQB, *NO_x, Emissions from HW's Missoula Pulp and Paper Mill*, August 24, 1974

9. *Implementation Plan for Control of Air Pollution in Montana*, Montana State Department of Health and Environmental Sciences - Air Quality Bureau, December 1, 1971

10. *Control Techniques for Nitrogen Oxide Stationary Sources*, U.S. Department of Health, Education and Welfare - National Air Pollution Control Administration, AP-67, March 1970

11. *State of the Art Review of Pulp and Paper Waste Treatment* (EPA R-2-73-184) April, 1973

12. *Laboratory and Controlled Experimental Stream Studies of the Effects of Kraft Effluents on Growth and Production of Fish*, Stream Improvement Technical Bulletin No. 259, National Council of the Paper Industry for Air and Stream Improvement, Inc., October, 1972

13. *Local Climatology Data*, Missoula, Montana (1972) U.S. Department of Commerce, NOAA

14. *An Evaluation of the Missoula Valley Air Quality*, prepared for Hoerner-Waldorf by Environmental Sciences and Engineering, Gainesville, Florida, March, 1974, p. 9

15. Telephone conversation, September 5, 1973, between David Maughan, Air Quality Bureau, and Dr. David Adams, Washington State University, Pullman, Washington

16. Carlson, C.C., 1974, *Sulfur Damage to Douglas-fir near a Pulp and Paper Mill in Western Montana*, USDA Forest Service Northern Region #74-13

17. Letter to David Maughan, AQB from D. T. Potts, HW, October 8, 1974

18. Novakov, R., et. al., Sulfates as Pollution Particles: Catalytic Formation on Carbon (Soot) Particles, Science, Vol. 186, October 18, 1974, p. 259-261

19. Thiller, R., et. al., Suspended Particulates and Relative Humidity Relative to Visibility Reduction, APCA Convention, Chicago, Illinois, June 24-28, 1973

20. Eagan, Richard C., et. al., Particle Emission From A Large Kraft Paper Mill and Their Effects on the Microstructure of Warm Clouds, Journal of Applied Meteorology, August, 1974, pp 535-552

21. Pettersson, Sverre, Weather Analysis and Forecasting, Vol II, 2nd ed., McGraw-Hill, 1965, p. 80

22. West, Phillip W., & J. Jaime Chaing, Spectrophotometric Determination of Atmospheric Acidity By Means of the Displacement of the Equilibrium of Acid-Base Indicators, Journal of Air Pollution Control Association, Vol. 24, No. 7, July 1974, pp 671-673

23. Barton, Dr. S. C. & Dr. H. G. McAdie, An Automated Instrument for Monitoring Ambient H_2SO_4 Aerosol, Proceedings of the Third International Clean Air Congress, Dusseldorf, 1973, pp C25-C27

24. Phone conversation Dave Maughan AQB and Eugene Pike, Missoula Electric Cooperative, October 22, 1974

25. Robinson, E. et. al., Sources, Abundance and Fate of Gaseous Atmospheric Pollutants, Stanford Research Institute, Menlo Park, California, February, 1968, N-71-25147

26. Liuiti, G., et. al., The Reaction of Hydrogen Sulfide and Atomic Oxygen, JACS, 88, 1966, pp. 3212-3215

27. Owen, G. L., Better Pollution Control at Hoerner-Waldorf's Missoula Pulp-and-Paper Mill under Expansion, Private Report, Spring 1974

28. Dightman, Richard A., A Comparison of Fog Incidence at Missoula, Montana with Surrounding Locations, Western Region Technical Memorandum No. 12, ESSA, August 1966

29. Simpson, Dr. R. E. Hope, Discussion of the Common Cold, Proceedings of the Royal Society of Medicine, Vol. 51, 267, Jan. 15, 1958

30. Anderson, Ib, MD.; Gunnar R. Lundquist, Aarhus Denmark; Donald F. Proctor, MD., Baltimore, Human Perception of Humidity Under Four Controlled Conditions, Arch. Environ. Health/Vol. 26, 21, Jan. 1973

31. Letter from Dr. Donald Proctor, MD. on humidity to David Maughan dated July 30, 1974

32. Amdur, Mary O., Animal Studies, Proceedings of the Conference of Health Effects of Air Pollutants, Committee on Public Works, United States Senate, Serial No. 98-15, November, 1973, pp. 175-206

33. Frank Dr. R., Dr. C. E. McJilton, Dr. R. J. Charlson, University of Washington, Sulfur Oxides and Particles; Effects on Pulmonary Physiology in Man and Animals; Proceedings of the Conference of Health Efforts on Air Pollutants, Committee on Public Work, United States Senate, Serial No. 98-15, November, 1973, pp 207-225

34. Carnow, Dr. Bertram W., Sulfur Oxides and Particles: Effects on Health, University of Illinois School of Public Health, Proceedings of the Conference of Health Efforts on Air Pollutants, Committee on Public Work, United States Senate, Serial No. 98-15, November, 1973, pp 263-275

35. Lewis, Trent R., Mary O. Amdur, Martin D. Fritzhand, Kirby I. Campbell, Division of Health Effects Research, Toxicology of Atmospheric Sulfur Dioxide Decay Products, EPA July 1972

36. Finklea, John L., et. al., Aggravation of Asthma by Air Pollutants: 1971 Salt Lake Basin Studies, Health Consequences of Sulfur Oxides; A report from Chess, 1970-1971, pp 2-75-2-91.

37. Bohac Robert, et. al., Draft on Soluble Sulfate and Respiratory Disease, University of Montana Student Environmental Research Center, National Science Foundation, September, 1974

38. Carnow, Bertram W. MD., et. al., Hydrogen Sulfide Health Effects and Recommended Air Quality Standard, Institute for Environmental Quality State of Illinois Document No. 74-24, March 1974.

39. Schieler, Leroy, PhD., Hydrogen Sulfide, Arch Intern. Med/Vol 132, December 1973, p 796

40. Shimpke, Tom, MD., Hearing Statement, August, 1974, Missoula, Montana

41. Beighle, Richard Dr., Hearing Statement, August 1974, Missoula Montana

42. Langes Handbook of Chemistry, Eleventh Edition, Edited by John A. Dean

43. Pryne, DVM., Personal Communication, October 22, 1974

44. Dickensen, Earl, DVM, Personal Communication, October, 1974

45. R. G. McMurtrey, R. L. Konizeski and Alex Brietkrietz, 1965, Geology and Ground Water Resources of the Missoula Basin, Montana. Montana Bureau of Mines and Geology bulletin 47.

46. Konizeski, R. L., no data, On the significance of the Hoerner-Waldorf Well Field Water - Table Fluctuations, Unpublished report.

47. Marcoux, Ron, 1974, Water Quality Monitoring on Clark Fork River - April to June, 1973. Memorandum from Mr. Ford to Mr. Powewitz, Montana Department of Fish and Game.

48. Water Quality Control Program for Hoerner-Waldorf Corporation Mill Expansion, Missoula, Montana, 1974. Hoerner-Waldorf Corporation. Unpublished report.

49. U. S. Environmental Protection Agency, 1974, Clark Fork River Study, Montana, July-August, 1973, Report by Technical Investigations Branch, Surveillance and Analysis Division, EPA, Region VIII.

50. *Revisions to Economic Section of Environmental Impact Statement on the Proposed Expansion of Hoerner-Waldorf: Missoula Pulp and Paper Mill* (HW, March 20, 1974)

51. Letter from Thomas M. Power and Malinda Schaill to SDHES, January 21, 1974.

52. Power, Thomas M., Schaill, Malinda, *The Economic Impact of the Proposed Hoerner-Waldorf Expansion: Some Critical Comments and a Proposal* (December, 1973)

53. Letter to Dr. John L. Anderson, October 15, 1974

54. Daubenmire, R., and J. B. Daubenmire, 1968. *Forest Vegetation of Eastern Washington and Northern Idaho*. Washington Agr. Exp. Sta. Tech. Bull. 60.

55. Environmental Protection Agency, 1973. *Effects on Sulfur Oxides in the Atmosphere on Vegetation*. Revised Chapter for Air Quality Criteria for Sulfur Oxides; Research Triangle Park, North Carolina.

56. Jacobson, J. A., and C. C. Hill, 1970. *Recognition of Air Pollution Injury to Vegetation: A Pictorial Atlas*. Air Pollution Control Association, Pittsburgh, Pennsylvania.

57. Linzon, S. N., 1965. *Sulfur Dioxide and Plant Response*, Journal of Occupational Medicine 10 (9) 516-524.

58. Daines, R. H., 1968. *Sulfur Dioxide and Plant Response*; J. Occupational Medicine, 10:516-524

59. Gordon, C. C., 1969. Hoerner-Waldorf Pre-trial Report to Garlington, 26 pp. University of Montana Botany Department, Missoula, Montana.

60. Carlson, C. C., *Sulfur Damage to Douglas-fir near a Pulp and Paper Mill in Western Montana*, USDA Forest Service Northern Region #74-13, 1974

61. Huey, N., 1968. *The Lead Dioxide Estimation of Sulfur Dioxide Pollution*, Journal Air. Pollution Control Association, 18(9):610-611.

62. Scheffer, T. C., and G. C. Hedgcock, 1955. *Injury to Northwestern Forest Trees by Sulfur Dioxide from Smelters*, Technical Bull. No. 1117.

63. Ecological Consulting Service, 1973. *The Brown Needle Study - An Analysis of Factors Causing Tree Needle Damage Near the Missoula Hoerner-Waldorf Mill*, 101 pp.

64. Carlstrom, R.C., 1972. *Winter Injury to Plants*. Cooperative Extension Service, Montana State University, Bozeman.

65. Curry, J. R., and T. W. Church, Jr., 1952. *Observation on Winter Drying Of Conifers in the Adirondacks*, Journal of Forestry, 50:114-116.

66. LeBlanc, F. and D. N. Rao, 1973. *Effects of Sulphur Dioxide on Lichen and Moss Transplants*, Ecology 54:612-617.

67. Sundstrom, K. R., and J. E. Hallgren, 1973. Using Lichens as Physiological Indicators of Sulphurous Pollutants, Ambio 2:13-21.

68. Saunders, P.J.W., 1970. Air Pollution in Relation to Lichens and Fungi, Lichenologist 4:337-349.

69. Sheridan, Richard P., Effects of Pulp Mill Emissions on Lichens in the Missoula Valley, Botany Department, University of Montana.

70. Unpublished Technical Report for Kraft Pulp Mills, EPA

71. Letter from J. Herlihy, EPA, to B. F. Wake, SDHES, April 26, 1974

72. Russell, John C. & Dumont Rush, Singmaster and Breyer Company, Air Pollution Control in the Primary Aluminum Industry, EPA Contract, CPA 70-21, Pul. # EPA-450/3-73-004

73. Vandegrift, A. Eugene, Larry J. Shannon, & Paul G. Gorman, Controlling Fine Particles, Chemical Engineering, June 18, 1973

74. Industrial Gas Cleaning Institute, IGCI, Newsletter, Journal of Air Pollution Control Association, Vol. 24, No. 9, September, 1974

APPENDIX A

AIR QUALITY REGULATIONS

Ambient air standards were developed to limit pollutant levels in the ambient air to a concentration low enough to protect health and property.

The emission standards restrict the quantity of pollutants a source can emit. They are as a general rule intended to require achievement of the "state-of-the-art" in pollution control.

Several ambient and emission regulations apply to H-W's proposed expansion. H-W is subject to two particular regulations; the S1430 "process weight" and S1450 "the particulate from fuel burning" regulations. Both limit particulate emission on a basis of the amount material used; the former on the total quantities processed, the latter on the total fuel burned. Reduced sulfur emissions (TRS) are regulated by S1470, Section 3, kraft pulp mills. This rule restricts emission of reduced sulfur to 17.5 ppm in the recovery furnace flue gases or to 0.087 #TRS/1000 lbs. of black liquor fired. Section (1) of this same regulation limits the amount of sulfur in fuel burned in a combustion device. Visible emissions are restricted by S1460, applicable to all sources in the mill. The state has adopted ambient air standards for sulfur dioxide, hydrogen sulfide, suspended particulate matter, and suspended sulfates. The numerical values are discussed in Section IIIA Air Quality.

APPENDIX B

APPLICABLE FEDERAL AND STATE LAWS, REGULATIONS, WASTE DISCHARGE PERMIT, AND COMMENTS

APPENDIX B

APPLICABLE FEDERAL AND STATE LAWS, REGULATIONS, WASTE DISCHARGE PERMIT, AND COMMENTS

PERTINENT MONTANA LAWS

Montana laws regarding water pollution control are contained in Sections 69-4801 through 69-4827, R.C.M. 1947. Particularly applicable sections are quoted below:

69-4802. Definitions. As used in this chapter, unless the context clearly indicates otherwise:

(5) "Pollution" means such contamination or other alteration of the physical, chemical or biological properties, of any state waters, as exceeds that permitted by Montana water quality standards, including but not limited to standards relating to change in temperature, taste, color, turbidity, or odor, or such discharge of any liquid, gaseous, solid, radioactive, or other substance into any state waters as will or is likely to create a nuisance or render such waters harmful, detrimental, or injurious to public health, recreation, safety, or welfare, or to livestock, wild animals, birds, fish or other wildlife, provided, however, that any discharge which is permitted by Montana water quality standards is not "pollution" for the purposes of this chapter;

69-4806. Pollution unlawful--permits. It is unlawful to:

(1) cause pollution as defined in section 69-4802 (5), R.C.M. 1947, of any state waters or to place or cause to be placed any wastes in a location where they are likely to cause pollution of any state waters;

(2) carry on any of the following activities without a current permit from the department;

  (a) construct, modify, or operate a disposal system which discharges to any state waters; or

  (b) construct or use any outlet for the discharge of sewage, industrial wastes, or other wastes to any state waters; or

(3) violate any limitation imposed by a current permit.

69-4808.2 Duties of board of health.

(1) The board shall:

  (c) review from time to time, at intervals of not more than three years, established classifications of waters and standards of water purity and classification, provided that

(3) the board shall require that any state waters whose existing quality is better than the established standards as of the date on which such standards become effective be maintained at that high quality unless it has been affirmatively demonstrated to the board that a change is justifiable as a result of necessary economic or social development and will not preclude present and anticipated use of such waters, and,

(4) the board shall require any industrial, public, or private project or development, which would constitute a new source of pollution or an increase source of pollution to high quality waters, referred to in (3) immediately above, to provide the degree of waste treatment necessary to maintain that existing high water quality;

STATE WATER QUALITY STANDARDS

The Montana water quality standards are set forth in MAC 16-2.14(10)-S14480.

The Clark Fork River is classified as B-D_1 and the most applicable standards sections for this classification are quoted below:

(d) B-D_1 classification

(i) Water-use description. The quality is to be maintained suitable for drinking, culinary and food processing purposes after adequate treatment equal to coagulation, sedimentation, filtration, disinfection and any additional treatment necessary to remove naturally present impurities; bathing, swimming and recreation; growth and propagation of salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply

(ii) Specific water quality criteria.

(aa) The average number of organisms in the fecal coliform group is not to exceed 200 per 100 milliliters, nor are 10 percent of the total samples during any 30-day period to exceed 400 fecal coliforms per 100 milliliters. The average number of organisms in the coliform group is not to exceed 1,000 per 100 milliliters, nor are 20 percent of the samples to exceed 1,000 coliforms per 100 milliliters during any 30-day period.

(ab) Dissolved oxygen concentration is not to be reduced below 7.0 milligrams per liter.

(ac) Induced variation of hydrogen ion concentration (pH) within the range of 6.5 to 8.5 is to be less than 0.5 pH unit.

Natural pH outside this range is to be maintained without change. Natural pH above 7.0 is to be maintained above 7.0.

(ad) The maximum allowable increase above naturally occurring turbidity is 5 Jackson Candle Units except as is permitted in the general water quality criteria.

(ae) A 1° F maximum increase above naturally occurring water temperature is allowed within the range of 32° F to 66° F; within the naturally occurring range of 66° F to 66.5° F, no discharge is allowed which will cause the water temperature to exceed 67° F; and where the naturally occurring water temperature is 66.5° F or greater, the maximum allowable increase in water temperature is 0.5° F. A 2° F per hour maximum decrease below naturally occurring water temperature is allowed when the water temperature is above 55° F, and a 2° F maximum decrease below naturally occurring water temperature is allowed within the range of 55° F to 32° F.

(af) No increases above naturally occurring concentrations of sediment, settleable solids or residues, which adversely affect the use indicated, are allowed.

(ag) Concentrations of toxic or other deleterious substances, pesticides and organic and inorganic materials including heavy metals, after treatment for domestic use, are not to exceed the recommended limits contained in the 1962 U. S. Public Health Service Drinking Water Standards or subsequent editions; also, maximum allowable concentrations are to be less than acute or chronic problem levels as revealed by bioassay or other methods.

(ah) True color is not to be increased more than five units above naturally occurring color.

(6) General water quality criteria.

(a) The degree of waste treatment required to restore and maintain the standards is to be determined by the department and is to be based on the following.

(i) The state's policy of nondegradation of existing high water quality as described in Section 69-4808.2, R.C.M. 1947.

(ii) Present and anticipated beneficial uses of the receiving water.

(iii) The quality and nature of flow of the receiving water.

(iv) The quantity and quality of the sewage, industrial waste or other waste to be treated.

(v) The presence or absence of other sources of pollution on the same watershed.

(b) Sewage is to receive a minimum of secondary treatment as defined by EPA in accordance with requirements set forth in the Federal Water Pollution Control Act Amendments of 1972.

(c) Industrial waste is to receive, as a minimum, treatment equivalent to the best practicable control technology currently available (BPCT) as defined by EPA. In cases where BPCT is not defined by EPA, industrial waste is to receive, after maximum practicable in-plant control, a minimum of secondary treatment or equivalent.

(d) For design of disposal systems, stream flow dilution requirements are to be based on minimum consecutive seven-day average flow which may be expected to occur on the average of once in ten years. When dilution flows are less than the above design flow at a point discharge, the discharge is to be governed by the permit conditions developed for the discharge through the waste discharge permit program.

(e) State surface waters are to be free from substances attributable to municipal, industrial, agricultural practices or other discharges that will:

(i) Settle to form objectionable sludge deposits or emulsions beneath the surface of the water or upon adjoining shorelines.

(ii) Create floating debris, scum, a visible oil film (or be present in concentrations at or in excess of 10 milligrams per liter) or globules of grease or other floating materials.

(iii) Produce odors, colors or other conditions as to create a nuisance or render undesirable tastes to fish flesh or make fish inedible.

(iv) Create concentrations or combinations of materials which are toxic or harmful to human, animals, plant or aquatic life.

(v) Create conditions which produce undesirable aquatic life.

(l) Existing discharges to state waters will be entitled a mixing zone as determined by the department.

(r) No wastes are to be discharged and no activities conducted which, either alone or in combination with other wastes or activities, will result in the dissolved gas content relative to the water surface to exceed 110 percent of saturation.

(s) Bioassay median tolerance concentrations are to be based on latest available research results for the materials, by bioassay tests procedures for simulating actual stream conditions as set forth in the latest edition of Standard Methods for the Examination of Water and Wastewater published by the American Public Health Association, or in accordance with tests or analytical procedures that have been found to be equal or more applicable by EPA. Bioassay studies are to be made using the most sensitive local species and life stages of economic or ecological importance; provided other species whose relative sensitivity is known may be used when there is difficulty in providing the most sensitive species in sufficient numbers.

When specific application factors are not available, the factor is to be determined by using methods listed in Water Quality Criteria published by the Federal Water Pollution Control Adminsitration (1968), or by using other methods accepted as equal or applicable by EPA.

(t) Metal limits for Clark Fork River (mainstem) from the confluence of Cottonwood Creek to the Idaho state line are:

Material	Average Daily Concentration ug/l	Maximum Instantaneous Concentration ug/l
Total copper	50	90
Dissolved copper	30	30
Total zinc	100	200
Dissolved zinc	70	80
Total iron	300	1,300
Dissolved iron	150	150
Total lead	50	50
Dissolved lead	50	50
Total cadmium	10	10
Total arsenic	10	10
Total mercury	1	1

A. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS - SEE ANY ADDITIONAL REQUIREMENTS UNDER PART III.

Immediate Effluent Limitations

During the period beginning immediately and lasting through July 14, 1975, the permittee is authorized to discharge from outfalls serial numbers 001, 002, 003, and 004, and by seepage.

Such discharges shall be limited by the permittee as specified below:

Discharges 001, 002, and 003 (direct discharge)

There shall be no discharge from these outfalls except during the spring high flow period. Discharges shall not commence until written permission is given by the Department. Discharge shall be terminated when requested orally or in writing by the Department.

Specific discharge requirements following the granting of permission to discharge are as follows:

1. 96-hour TL_{50} - The combined rate of direct discharge shall not exceed the following formula:

$$\text{Rate of waste discharge} = \left(\begin{array}{c}\text{96-hr } TL_{50} \text{ of the wastewater} \\ \text{expressed as a decimal}\end{array}\right) \times \text{River Flow} \times 0.02$$

   where rate of discharge and river flow are in the same units; if contribution is from more than one pond, discharge rate shall be proportioned according to TL_{50} results and contributing flow from the respective ponds.

2. In addition to the above requirements, the Department may require additional limitations as part of its written permission to discharge.

Discharge 004

Waste discharged through outfall 004 shall consist entirely of uncontaminated cooling water and shall be limited to a maximum flow of 6.0 mgd and shall not exceed 90 degrees F.

Seepage

Seepage shall achieve not less than 85 percent removal of BOD_5 in the wastewater seeping to the river.

Interim Effluent Limitations

During the period beginning July 15, 1975, and lasting through February 28, 1977, the permittee is authorized to discharge from outfalls serial number 001, 002, 003, and 004, and by seepage.

Such discharges shall be limited by the permittee as specified below:

Discharges 001, 002, 003, and Seepage

There shall be no discharges from outfalls 001, 002, and 003, except during the spring high flow period. Discharges shall not commence until written permission is given by the Department. Discharges shall be terminated when requested orally or in writing by the Department.

Specific discharge requirements following the granting of permission to discharge are as follows. Whichever limitation provides the most stringent control shall govern.

1. 96-hour TL_{50} - The combined rate of direct discharge shall not exceed the following formula:

   $$\text{Rate of waste discharge} = \left(\begin{array}{c}\text{96-hour } TL_{50} \text{ of the wastewater} \\ \text{expressed as a decimal}\end{array}\right) \times \text{River Flow} \times 0.02$$

   where rate of discharge and river flow are in the same units; if contribution is from more than one pond, discharge rate shall be proportioned according to TL_{50} results and contributing flow from the respective ponds.

2. The combined spring discharge shall not contain more than 2,000,000 pounds of total suspended solids.

3. Total annual discharge of BOD_5 in the direct discharge and seepage combined shall not exceed 2,250,000 pounds.

4. pH - pH of the discharge shall be within the range of 6.0 and 9.0.

5. There shall be no discharge of floating solids or visible foam in other than trace amounts.

6. In addition to the above requirements, the Department may require additional limitations as part of its written permission to discharge.

Discharge 004

Waste discharge through outfall 004 shall consist entirely of uncontaminated cooling water and shall be limited to a maximum flow of 6.0 mgd and shall not exceed 90 degrees F.

Final Effluent Limitations

During the period beginning March 1, 1977 and lasting through December 31, 1977 the permittee is authorized to discharge from outfalls serial number 001, 002, 003, and 004, and by seepage.

Such discharges shall be limited by the permittee as specified below:

Discharges 001, 002, 003, and Seepage

There shall be no discharges from outfalls 001, 002, and 003, except during the spring high flow period. Discharges shall not commence until written permission is given by the Department. Discharges shall be terminated when requested orally or in writing by the Department.

Specific discharge requirements following the granting of permission to discharge are as follows. Whichever limitation provides the most stringent control shall govern.

1. 96-hour TL_{50} - The combined rate of direct discharge shall not exceed the following formula:

   $$\text{Rate of waste discharge} = \left(\begin{array}{c}\text{96-hour } TL_{50} \text{ of the wastewater} \\ \text{expressed as a decimal}\end{array}\right) \times \text{River Flow} \times 0.02$$

   where rate of discharge and river flow are in the same units; if contribution is from more than one pond, discharge rate shall be proportioned according to TL_{50} results and contributing flow from the respective ponds.

2. Color - The combined rate of direct discharge shall also not exceed the following formula:

   $$D = \frac{(Q)\quad(5)}{Cd-(C_r+5)}$$

   where:

D is the rate of discharge in cfs
Q is the river flow in cfs
Cd is the color of the discharge in SCU
Cr is the background color of the river in SCU

3. BOD_5 - The combined rate of direct discharge shall also not exceed the following formula:

$$D = \frac{2.5Q}{Cp-5} \quad \text{where:}$$

D is the rate of discharge in cfs
Q is the river flow in cfs
Cp = concentration of BOD_5 in the discharge in mg/l

4. The combined spring discharge shall not contain more than 2,000,000 pounds of total suspended solids.

5. Total annual discharge of BOD_5 in the direct discharge and seepage combined shall not exceed 2,250,000 pounds.

6. pH - pH of the discharge shall be within the range of 6.0 and 9.0.

7. There shall be no discharge of floating solids or visible foam in other than trace amounts.

8. In addition to the above requirements, the Department may require additional limitations as part of its written permission to discharge.

Discharge 004

Waste discharge through outfall 004 shall consist entirely of uncontaminated cooling water and shall be limited to a maximum flow of 6.0 mgd and shall not exceed 90 degrees F.

Monitoring Requirements

1. During the non-discharge season, the permittee shall monitor each pond containing at least one-fourth of its capacity of stored wastewater once per month for BOD_5 and sodium. Ponds containing less than one-fourth of capacity of stored wastewater shall be reported as such. In addition, the remaining capacity of each pond at the end of each month shall be determined.

2. River flow shall be measured at U.S.G.S. Station 12-3530.

3. The 96-hour TL_{50} shall be determined as specified in Standard Methods for the Examination of Water and Wastewater (latest edition) for static bioassays. Test fish shall be rainbow trout or more typical species of fish if so ordered by the Department.

4. Flow measurements in the discharge pipes must indicate values within 10% of the true flow value. Adequate flow measuring devices, such as Venturi or orifice meters shall be installed in the outlet pipes no later than January 1, 1975, to achieve this degree of accuracy. Adequacy of the flow measuring equipment shall be determined by the Environmental Protection Agency and the Department.

5. During the discharge season, the permittee shall sample and test the contents of each pond containing waste in accordance with the following schedule:

Parameter	Frequency	Sample Type
96-hour TL_{50}	once not more than 14 days before discharge from each pond	Grab
BOD_5	"	Grab
Color	"	Grab
pH	"	Grab
Total Phosphorus (as p)	"	Grab
Ammonia (as N)	"	Grab
Nitrate-Nitrite (as N)	"	Grab
Total Organic Nitrogen	"	Grab

6. The permittee shall monitor each direct outlet discharging waste from two or more ponds prior to entry into the river in accordance with the following schedule:

Parameter	Frequency	Sample Type
Flow	Daily	Instantaneous
96-hour TL_{50}	Weekly	Grab
BOD_5	Weekly	Grab
Total Suspended Solids	Weekly	Grab
Color	Weekly	Grab
pH	Weekly	Grab
Total Phosphorus (as P)	Weekly	Grab
Ammonia (as N)	Weekly	Grab
Nitrate-Nitrite (as N)	Weekly	Grab
Total Organic Nitrogen	Weekly	Grab

7. The permittee shall note on a daily basis for each direct discharge outlet during the discharge period the ponds being discharged and estimated flow from each pond.

8. The permittee shall monitor test wells 1R, 2R, 4R, 5R, 404, 421, 423, and 514 once every two months for BOD_5, Color and Sodium. In addition, the elevation of the water level in each test well shall be determined once every two months.

9. Discharge #004 shall be monitored for flow and temperature by instantaneous sampling once a week in the drain ditch prior to entry into the river.

10. During the non-discharge season, the permittee shall monitor the Clark Fork River at monthly intervals at Harper Bridge and at the established monitoring points commonly referred to as Marcure Ranch and Six Mile Station. Grab samples shall be collected and analyzed for color and dissolved oxygen. Dissolved oxygen sampling shall occur during the one-hour period preceding sunrise.

    During the direct discharge season, the permittee shall monitor the Clark Fork River weekly at the above stations for the same parameters. Dissolved oxygen sampling shall occur during the one-hour period preceding sunrise.

11. Additional monitoring requirements may be included by the Department in the written permission for direct discharge.

B. SCHEDULE OF COMPLIANCE

1. The permittee shall achieve compliance with the effluent limitations specified for discharges in accordance with the following schedule:

   The permittee shall submit to the Department in less than ninety (90) days after the issuance of this permit, an implementation plan for an abatement program designed to achieve the effluent limitations specified in this permit for discharge from outfall(s) 001, 002, and 003. The implementation plan shall consist of an outline of intended design, construction and operation, including a compliance schedule setting forth the dates by which compliance with the effluent limitations will be reached. The compliance schedule shall include, where appropriate, dates to accomplish the following:

   (a) completion of preliminary plans

   (b) completion of final plans

   (c) award of contract(s)

   (d) commencement of construction

   (e) completion of major construction phases

   (f) completion of all construction

   (g) attainment of operational level

   Upon approval of the implementation plan by the Department, the schedule of compliance shall become conditions of this permit.

2. In addition, the permittee shall provide a compliance schedule, in less than thirty (30) days including, where appropriate, dates to accomplish (a) through (g) above for installation and operation of the APS bleaching system by October 1, 1975.

3. No later than 14 calendar days following a date identified in the above schedule of compliance, the permittee shall submit either a report of progress or, in the case of specific actions being required by identified dates, a written notice of compliance or noncompliance. In the latter case, the notice shall include the cause of noncompliance, any remedial actions taken, and the probability of meeting the next scheduled requirement.

   Compliance and interim reporting dates shall be for periods not to exceed nine (9) months and to the extent practical shall fall in the last day of March, June, September, and December.

C. MONITORING AND REPORTING REQUIREMENTS

1. *Representative Sampling*

Samples and measurements taken as required herein shall be representative of the volume and nature of the monitored discharge.

2. *Reporting*

Monitoring results obtained during the previous month shall be summarized and reported on a Discharge Monitoring Report Form (EPA No. 3320-1), postmarked no later than the 28th day of the month following the completed reporting period. The first report is due on January 28, 1975. Duplicate signed copies of these, and all other reports herein, shall be submitted to the Department and the Regional Administrator at the following addresses:

(a) Montana Department of Health
and Environmental Sciences
Water Quality Bureau
Board of Health Building
Helena, Montana 59601

(b) Regional Administrator
U. S. Environmental Protection
Agency
Suite 900, 1860 Lincoln Street
Denver, Colorado 80203

Attention: Permits Branch

Note: If no discharge occurs during the reporting period, "no discharge" shall be reported, in letter form, to the above agencies. Data not adaptable to the above form shall be included as attachements.

3. *Definitions*

(a) The "Act" means the Federal Water Pollution Control Act Amendments of 1972, PL 92-500.

(b) The "Administrator" means the administrator of the United States Environmental Protection Agency.

(c) The "Department" means the Montana Department of Health and Environmental Sciences.

(d) The "EPA" means the United States Environmental Protection Agency.

(e) A "grab" sample, for monitoring requirements, is defined as a single "dip and take" sample collected at a representative point in the discharge stream.

(f) An "instantaneous" measurement, for monitoring requirements, is defined as a single reading, observation, or measurement using acceptable monitoring equipment.

(g) The "Regional Administrator" means the administrator of the region of EPA with jurisdiction over federal water pollution control activities in the state of Montana.

4. *Test Procedures*

Test procedures for the analysis of pollutants shall conform to regulations published in or subsequent revisions to the Federal Register, October 16, 1973, Vol. 38, Number 199, Part II. Sample collection and preservation shall be in accordance with the best methods technologically feasible, and shall be in a manner acceptable to the Department. (The EPA Region VIII Treatment and Preservation Guide should be consulted for acceptable sample collection and preservation techniques.)

All flow measuring and flow-recording devices used in obtaining data submitted in self-monitoring reports must indicate values within 10 percent of the actual flow being measured.

5. *Recording of Results*

For each measurement or sample taken pursuant to the requirements of this permit, the permittee shall record the following information:

(a) The exact place, date, and time of sampling;

(b) The dates the analyses were performed;

(c) The person(s) who performed the analyses;

(d) The analytical techniques or methods used; and

(e) The results of all required analyses.

6. *Additional Monitoring by Permittee*

If the permittee monitors any pollutant at the location(s) designated herein more frequently than required by this permit, using approved analytical methods as specified above, the results of such monitoring shall be included in the calculation and reporting of the values required in the Discharge Monitoring Report Form (EPA No. 3320-1). Such increased frequency shall also be indicated.

7. *Records Retention*

All records and information resulting from the monitoring activities required by this permit including all records of analyses performed and calibration and maintenance of instrumentation and recordings from continuous monitoring instrumentation shall be retained for a minimum of three (3) years, or longer if requested by the Department or the Regional Administrator.

A. MANAGEMENT REQUIREMENTS

1. *Change in Discharge*

All discharges authorized herein shall be consistent with the terms and conditions of this permit. The discharge of any pollutant identified in this permit more frequently than or at a level in excess of that authorized shall constitute a violation of the permit. Any anticipated facility expansions, production increases, or process modifications which will result in new, different, or increased discharges of pollutants must be reported by submission of a new MPDES application or, if such changes will not violate the effluent limitations specified in this permit, by notice to the Department of such changes. Following such notice, the permit may be modified to specify and limit any pollutants not previously limited.

2. *Noncompliance Notification*

If, for any reason, the permittee does not comply with or will be unable to comply with any effluent limitation specified in this permit, the permittee shall provide the Department and the Regional Administrator with the following information, in writing, within five (5) days of becoming aware of such condition:

(a) A description of the discharge and cause of noncompliance; and

(b) The period of noncompliance, including exact dates and times; or, if not corrected, the anticipated time the noncompliance is expected to continue, and steps being taken to reduce, eliminate and prevent recurrence of the noncomplying discharge.

3. *Facilities Operation*

The permittee shall at all times maintain in good working order and operate as efficiently as possible all treatment or control facilities or systems installed or used by the permittee to achieve compliance with the terms and conditions of this permit.

4. *Adverse Impact*

The permittee shall take all reasonable steps to minimize any adverse impact to state waters resulting from noncompliance with any effluent limitations specified in this permit, including such accelerated or additional monitoring as necessary to determine the nature and impact of the noncomplying discharge.

5. *Bypassing*

Any diversion from or bypass of treatment or control facilities or systems necessary to maintain compliance with the terms and conditions of this permit is prohibited, except (i) where unavoidable to prevent loss of life or severe property damage, or (ii) where excessive storm drainage or runoff would damage any facilities necessary for compliance with the effluent limitations and prohibitions of this permit. The permittee shall promptly notify the Department and the Regional Administrator in writing of each such diversion or bypass.

If, for other reasons, a partial or complete bypass of the wastewater treatment facilities is considered necessary, a request for such bypass shall be submitted to the Department and to the Regional Administrator at least sixty (60) days prior to the proposed bypass. If the proposed bypass is judged acceptable by the Department and by the Regional Administrator, the bypass will be allowed subject to limitations imposed by the Department and the Regional Administrator.

If, after review and consideration, the proposed bypass is determined to be unacceptable by the Department and the Regional Administrator, or if limitations imposed on an approved bypass are violated, such bypass shall be considered a violation of this permit; and the fact that application was made, or that a partial bypass was approved, shall not be defense to any action brought thereunder.

6. *Removed Substances*

Solids, sludges, filter backwash, or other pollutants removed in the course of treatment or control of wastewaters shall be disposed of in a manner such as to prevent any pollutant from such materials from entering state waters.

7. *Power Failures*

In order to maintain compliance with the effluent limitations and prohibitions of this permit, the permittee shall either:

(a) In accordance with the Schedule of Compliance contained in Part I, provide an alternative power source sufficient to operate the wastewater control facilities;

or, if such alternative power source is not in existence, and no date for its implementation appears in Part I,

(b) Halt, reduce or otherwise control production and/or all discharges upon the reduction, loss of failure of the primary source of power to the wastewater control facilities.

B. RESPONSIBILITIES

1. *Right of Entry*

The permittee shall allow the head of the Department, the Regional Administrator and/or their authorized representatives, upon the presentation of credentials:

(a) To enter upon the permittee's premises where an effluent source is located or in which any records are kept; and

(b) At reasonable times to have access to and copy any records required to be kept under the terms and conditions of this permit; to inspect any monitoring equipment or monitoring method required in this permit; and to sample any discharge of pollutants.

2. *Transfer of Ownership or Control*

In the event of any change in control or ownership from which the authorized discharges emanate, the permittee shall notify the succeeding owner or controller of the existence of this permit by letter, a copy of which shall be forwarded to the Department and the Regional Administrator.

3. *Availability of Reports*

Except for data determined to be confidential under Section 308 of the Act, all reports prepared in accordance with the terms of this permit shall be available for public inspection at the offices of the Department and the Regional Administrator. As required by the Act, effluent data shall not be considered confidential. Knowingly making any false statement on any such report may result in the imposition of criminal penalties as provided for in Section 69-4823 (6), R.C.M. 1947.

4. *Permit Modification*

After notice and opportunity for a hearing, this permit may be modified, suspended, or revoked in whole or in part during its term for cause including, but not limited to, the following:

(a) Violation of any terms or conditions of this permit;

(b) Obtaining this permit by misrepresentation or failure to disclose fully all relevant facts; or

(c) A change in any condition that requires either a temporary or permanent reduction or elimination of the authorized discharge.

5. *Toxic Pollutants*

Notwithstanding Part II, B-4 above, if a toxic effluent standard or prohibition (including any schedule of compliance specified in such effluent standard or prohibition) is established under Section 307(a) of the Act for a toxic pollutant which is present in the discharge and such standard or prohibition is more stringent than any limitation for such pollutant in this permit, this permit shall be revised or modified in accordance with the toxic effluent standard or prohibition and the permittee so notified.

6. *Civil and Criminal Liability*

Except as provided in permit conditions on "Bypassing" (Part II, A-5) and "Power Failures" (Part II, A-7), nothing in this permit shall be construed to relieve the permittee from civil or criminal penalties for noncompliance.

7. *Oil and Hazardous Substance Liability*

Nothing in this permit shall be construed to preclude the institution of any legal action or relieve the permittee from any responsibilities, liabilities, or penalties to which the permittee is or may be subject under Section 311 of the Act.

8. *Property Rights*

The issuance of this permit does not convey any property rights in either real or personal property, or any exclusive privileges, nor does it authorize any injury to private property or any invasion of personal rights, nor any infringement of Federal, State or local laws or regulations.

9. *Severability*

The provisions of this permit are severable, and if any provision of this permit, or the application of any provision of this permit to any circumstance, is held invalid, the application of such provision to other circumstances, and the remainder of this permit, shall not be affected thereby.

OTHER REQUIREMENTS

Violation of Water Quality Standards

If river data resulting from the water quality monitoring program shows violation of established water quality standards, including the introduction of taste and odor problems, this permit may be modified to specify additional control measures to ensure compliance with water quality standards.

COMMENTS REGARDING COMPLIANCE SCHEDULE AND STANDARDS

The Federal Water Pollution Control Act Amendments of 1972 require that, as a minimum, industries provide best practicable control technology (BPCT) by no later than July 1, 1977. Under MPDES regulation MAC 16-2.14(10)-S14460, Section (2), the minimum effluent standards are the same as those adopted by EPA. The aerated lagoon system that HW is constructing and will place into operation in late 1974 or early 1975 will provide an effluent that should be capable of meeting BPCT for the existing discharge and the proposed expansion. The consultants for HW also indicate that the waste treatment system should be capable of meeting best available control technology (BACT) for all parameters with the possible exception of color.

Additional treatment is required if necessary to meet the state's water quality standards. Following stream survey work during 1973, an additional compliance schedule for color was established by the department during early 1974 and is required to be met by March 1, 1977. With regard to this compliance schedule, HW, in their letter of October 15, 1974, stated:

> As was pointed out today, Hoerner Waldorf is committed to a firm compliance schedule to meet color removal. Rapid infiltration looks encouraging, and is, thusfar, believed to be the best alternative to achieve color removal. However, if data collected between now and next summer indicates the associated problems cannot be overcome, there are other color removal aternatives available to be employed, such as massive or mini lime treatment, adsorption and others or in-plant process modifications (APS bleaching), or a combination of treatment, process changes. Color removal is still a new and developing field. It is too early to state at this time which engineering approach will be taken if the chosen route does not prove fully successful, since there is an interdependency between equipment requirements, plant expansion and process modification. We will keep you informed of any work on possible alternatives if they become necessary.

It should be noted that the MPDES discharge permit under which HW will be operating will guarantee that the state's water quality standards are met with respect to color. It also places limits on the amount of BOD_5 and TSS allowed to be discharged in line with BPCT requirements.

The goal of the federal act is to have no discharge of pollutants to the nation's waters by 1985. The practicality and feasibility of meeting this goal is presently being studied by the National Commission on Water Quality.

Technically, for the HW mill expansion, the non-degradation requirements set forth in Section 69-4808.2(1)(c)(3) and (4) are interpreted as being met as long as there is no increase in the amount of pollutants in the total loading from the existing mill (prior to installation of the aerated lagoon system). However, it should be noted that HW is not presently providing adequate effluent treatment and, therefore, was given a compliance schedule by the Board of Health to provide a minimum BPCT treatment by July 15, 1975. Based on the previous discussion, it is felt that the aforementioned non-degradation requirements will be met as long as the effluent produced by the expanded mill meets the BPCT performance standards for the mill based on production prior to expansion.

Montana, like almost all the other states, has not established groundwater standards. Work has begun on developing a proposed regulation, but adoption of such a regulation is not expected for at least a year.

APPENDIX C

QUALITY CONTROL OF GAS CHROMATOGRAPH MONITORING

Department of Health and Environmental Sciences
STATE OF MONTANA HELENA, MONTANA 59601

John S. Anderson M.D.
DIRECTOR

December 19, 1973

Mr. Roy Countryman, Manager
Hoerner-Waldorf Corporation
Missoula, MT 59801

Dear Mr. Countryman:

We are enclosing what we consider essential to a study and quality control program for the ambient sampling around the Hoerner-Waldorf pulp mill. An environmental study must be based on reliable data which is comprehensive enough to be credible. The quality of any environmental impact statement will be largely dependent on the time allowed for the study and the professional competence of the personnel who participate.

Regarding the routing of the gas chromatograph strip charts, we think that for several reasons, including anticipated and already voiced criticism of the sampling program, it is of utmost importance that the charts be read and evaluated by the Department of Health and Environmental Sciences personnel before the charts are shipped out of the state to the contractor.

The Department of Health and Environmental Sciences must have discretion as to the adequacy and reliability of data and information furnished by the applicant. It is important, therefore, that we begin the complete collection of this data now so that we can verify your sampling results as the study proceeds and be able to make our decision on a construction permit as soon as is possible.

Sincerely,

Don Holtz

Donald R. Holtz, Chief
Air Quality Bureau

DRH:ADM:dmg
Enclosures

cc: Dr. John S. Anderson
Steve Brown
Roland Samel

I. Tracor Gas Chromatographs

1. Calibration

Once each two weeks a multipoint calibration is to be performed on each machine; that is, with given permeation tubes (they may be combined) the flow rates are changed such that different concentrations are obtained to plot calibration curves and to check for linearity. If there are questions as to which peaks correspond to given parameters, it may be necessary to run individual retention time relationships on permeation tubes on an independent basis. All instrument settings, flow rates, temperatures, calibration curves, copy of sections of chart paper including the calibrations, and so forth are to be recorded and/or pasted into the log book. More detail about log book notation is submitted below. Calibration of flow rates must also be made during this general calibration.

2. Permeation Tubes

Since two columns are involved (a. special silica gel; b. teflon column packed with teflon and coated with polyphenyl ether) the following certified and/or calibrated permeation tubes are required: sulfur dioxide, hydrogen sulfide, methyl mercaptan, ethyl mercaptan, propyl mercaptan, carbonyl sulfide, dimethyl sulfide. For permeation tubes, date received, nominal shelf life at a given temperature, tube length and permeation rate in nanograms/min per cm. of tube length at given temperatures must be stated in the log books. Zero air or suitable air scrubbers must be used during calibration for the air which passes over the permeation tubes.

3. Columns

a. Tracor silica gel columns are used both for the scrubber and analyti columns. Moisture, dirt or other causes may deteriorate one or either of the above columns. Such deterioration of columns is evidenced by peak broadening and distortions along with possible changes in peak retention time. Even with backflushing of the scrubber column, the above may occur. It is, therefore, necessary to have additional columns readily available or on hand.

b. Teflon columns (packed with teflon and coated with polyphenyl ether) on scrubber and analytical segments are also influenced by the above discussion. This column will not be routinely used--it will be installed on each analyzer (both on scrubber and analytical column) at least six hours per month and at times when significant readings are evidenced by the silica gel column. Each cycle should run at least 10 minutes.

4. Log Books

Daily entries into the log books need to be made for the following: pressure or flow rates for both hydrogen supplies, carrier gas and sample; regulator settings for cylinders; sample loop size; description of column being used; temperature readings for detector and column; trailer or room temperature; can sulfur odor be detected outside the enclosure?; estimated wind speed and direction; chart recorder speed and millivolt setting; any visitors to trailer logged in (visitors are any persons other than the operator). Log books are to be retained with each chromatograph. Daily record sheets are sufficient for the bubblers, hi-vol samplers and wind machines.

5. Trailer or Building

Temperature within building or trailer must be held constant. Also access to the enclosure must be limited to authorized personnel (all excepting operator must sign in along with date and time). All doors must be left locked when no one is attending monitoring equipment.

6. Data

Original charts from the chart recorders will be forwarded directly upon removal from the recorder and before they leave the state via certified mail to the Air Quality Bureau either weekly or as each chart roll is changed. This chart will be read and forwarded to the contractor in Flordia. A copy of all calibration data essential for reading the chart must accompany the chart recording. A copy of the log book record for the last calibration should suffice for this requirement. The contractor or the company must have availalbe the chart recordings which leave the state for future reference.

On the chart recording will be recorded with each servicing or daily check rotometer, pressure gauge and column and detector temperatures, date, time (draw line to exact time), zero or baseline reading (draw an arrow to this baseline reading), attenuation where it applies, whether can smell sulfur compound outside, estimated wind speed and direction, malfunctions, operator signature and specific column in use.

II. Wind Systems

Instruments need to be calibrated monthly for direction and temperature (where applicable). Daily sheets will be filled out at least five days a week. Enclosed is a copy of the necessary daily record sheet. Chart recordings from the Hill station and daily sheets for both weather systems will be mailed along with the chart recordings to the Air Quality Bureau on a weekly or monthly basis. The Bureau will reduce the Hill data with Environmental Science and Engineering doing the Frenchtown station. This latter reduced to sixteen points wind data will be forwarded to us as it is available.

III. Bubblers

Integrated gas bubblers will be maintained at the Hill site for sulfur dioxide. ~~and hydrogen sulfide.~~ Calibration of the limiting orifices will be performed monthly with the flow rates being recorded in a log book. Impingers must be identified and correlated to the limiting orifice; color coding works best for this.

The Reference method (Appendix A, Fed. Reg. 36. No. 84, Part II) for sulfur dioxide is enclosed for your information and must be followed as to sample handling and storage, chemical analysis, calculations, etc. ~~The method for the hydrogen sulfide bubblers is the tentative method as given in the book Methods of Air Sampling and Analysis, an Interscience Committee publication, 1972 edition.~~

Precaution must be made to insure that the impingers are heated, that timers record correct total times, the teflon tubing is used as an inlet to impingers, and that correct flow rates are maintained.

The Air Quality Bureau requires samples be split on a random sampling basis as indicated on the enclosed sheet which lists Month, Date and Day. Sulfur dioxide samples will be sent to the Air Quality Bureau in Helena. ~~and hydrogen sulfide samples will be given to Roland Samel in Missoula for chemical analysis.~~

IV.

Hi-vol samplers will be operated as indicated in the enclosed Federal Register. The necessary hi-vol calibrations need to be performed once each two months. Use of the enclosed calibration form is encouraged. Hi-vol samples will be operated at all three sites for 24-hour sampling periods. Filters must be pre-equilibrated 24-hours both before original and final weighings in a relative humidity range not to exceed 40% nor below 20%.

Each hi-vol filter must be accompanied by documentation as to weather conditions, winds, visifloat readings, etc. (See enclosed sheet). Each filter must be serialized and used only if it is intact; i.e., without tear or fold before the field run.

V.

The Bureau may request the monitor enclosed within the trailer, the wind system and the hi-vol sampler be moved to some other site during the time of the study.

APPENDIX D

DIFFUSION MODEL FOR HOERNER WALDORF

UPDATED DIFFUSION MODEL FOR HOERNER WALDORF

I. Hydrogen Sulfide

A. Pond Emissions

The H_2S emissions from the pond were assumed to result from an area source. When working with an area source, an imaginary point source is selected from which the emissions are theorized to originate. The selection of the theoretical point source is achieved by assuming a horizontal standard deviation of σy_o at the pond location. From Turner (1969) $\sigma y_o = S/4.3$ where S is the distance of a side of a square area source. If the area of the pond were measured to be a square of 20 acres (871,200 ft^2), a side dimension would be 933 feet. Therefore, $\sigma y_o = 933\ ft/4.3 = 217\ ft = 66.2\ m$.

For a given Pasquill category $\sigma y_o = a X_y^b$ where a and b are constants. The constants a and b and the virtual distance χ_y are given for the six Pasquill categories in Table D-1. For each category, the location of the theoretical point source varies.

Table D-1

Pasquill Category	a	c	b	d	Virtual Distance (χ_y) in Km	Wind Speed m/sec	Ambient H_2S Concentration over Ponds in PPB for ½ hour
A	.20	.45	.88	2.1	.28	1.565	117.8
B	.16	.11	.88	1.1	.37	1.565	111.2
C	.10	.061	.88	0.92	.63	2.7	62.6
D	.07	.033	.88	0.60	.94	2.7	67.1
E	.052	.023	.88	0.51	1.32	2.0	89.2
F	.035	.015	.88	0.45	2.06	2.0	56.6

Once the virtual distances (χ_y) have been calculated, the dispersion model can be applied. The equation used to estimate ambient levels was taken from Turner (1969). The equation (Equ. 3.4 of Turner) for a ground level source with no effective plume is stated below. Since there is some plume rise associated with the ponds but no measurable exit velocity, an effective stack height is assumed equal to observed heights (approximately 30 meters). However, it is likely that conditions will occur when plume rise from the ponds may be nonexistent, and under such conditions, H_2S concentrations would be expected to approach standards. However, there is no documented information available to adequately describe the frequency of such conditions.

$$\chi = \frac{Q}{\pi \sigma_y \sigma_z u} \qquad \text{Equ. 3.4 of Turner}$$

χ = ambient ground level concentration in g/m^3

Q = H_2S emission rate from ponds and foul condensates = 4.2 g/sec

σ_y = horizontal standard deviation of plume in meters $\sigma_y = ax^b$

σ_z = vertical standard deviation of plume in meters $\sigma_z = cx^d$

u = wind speed = 1.5-2.7m/sec (depending on Pasquill category)

The ambient estimates have units of g/m^3 for 10-minute periods. These values were converted to one-half hour averages with units of parts per billion (PPB). The conversion is shown below:

$$\chi \left(\frac{g}{m^3}\right) = \chi \left(\frac{g}{m^3}\right) \left(\frac{1000000\ \mu g}{g}\right) \left(\frac{1.000\ PPB}{1.4\ \mu g/m^3}\right) = \chi\ (PPB)\ \text{10-minute period}$$

$$\chi \left(\frac{10\ min.}{30\ min.}\right)^{.44} = \chi\ (PPB)\ \text{30-minute period}$$

Ambient levels were estimated for six Pasquill categories at 3 kilometer intervals from the ponds. Results of these estimates are shown in Table D-2. Values within 3 Km are questionable as the virtual point source method used gives a very rough estimate at close points.

Table D-2

Ground Level H_2S Estimates from Hoerner Waldorf Ponds

(Proposed 1974)

Flat Terrain Assumed
Units are in Parts per Billion H_2S for One-Half Hour

			Pasquill Category			
Wind	A	B	C	D	E	F
(m/sec)→	1.565	1.565	2.7	2.7	2.0	2.0
Distance Downwind (Km)						
3	.12	1.95	3.51	11.6	26.9	30.6
6	.02	.55	1.19	5.2	14.0	19.3
9	---*	.27	.61	3.1	9.0	10.4
12	---*	.15	.37	2.1	6.4	8.3
15	---*	.08	.26	1.6	4.9	6.8
18	---*	.07	.19	1.2	3.9	5.8
21	---*	.05	.14	1.0	3.2	4.9

---

*Less than 0.01 PPB.

B. Stack Emissions

The short-term dispersion model was also utilized to estimate ground level concentrations from the HW stacks. A different version of the model as outlined in Turner (Equ. 3.1) was utilized for stack emissions. This equation is given below:

$$\chi = \frac{Q}{\pi \sigma_y \sigma_x u} \left[\exp -\tfrac{1}{2} \left(\frac{H}{\sigma_z} \right)^2 \right] \qquad \text{Equ. 3.3 of Turner}$$

The stack parameters were averaged by weighted methods. Such assumptions provide that all emissions come from a single stack. The theoretical stack parameters are listed below.

H = effective stack height = 170 m

Q = emission rate = 2.7 g/sec

u = wind speed = 1.5-2.7 m/sec (depending on Pasquill category)

y = horizontal deviation from plume centerline = 0 m

σ_y = horizontal standard deviation $\sigma_y = ax^b$

σ_z = vertical standard deviation $\sigma_z = cx^d$

Results of the model are listed in Table D-3. These results assume flat terrain and would occur at points parallel to the axis of the valley bottom.

Table D-3

Ground Level H_2S Estimate from Hoerner Waldorf Stacks

(Proposed 1974)

Flat Terrain Assumed
Units are in Parts per Billion H_2S for One-Half Hour

		Pasquill Category					
	Wind	A	B	C	D	E	F**
	(m/sec) →	1.565	1.565	2.7	2.7	2.0	2.0
Distance Downwind (Km)	3	.10	1.42	1.95	.35	---*	---*
	6	---*	.39	.80	.93	.16	---*
	9	---*	.18	.42	.93	.42	---*
	12	---*	.11	.26	.80	.59	---*
	15	---*	.07	.17	.67	.67	.04
	18	---*	.05	.13	.57	.69	.07
	21	---*	.04	.09	.48	.68	.09

---

*Less than 0.01 PPB.

**For category F, a maximum of 0.41 PPB would theoretically result at approximately 70 Km downwind.

If elevation were incorporated into the dispersion model for the plant emissions, the maximum concentration would result at an elevation equivalent to the effective plume rise (170 meters above stack base). The nearest point with such an elevation in the vicinity of the HW facilities would be approximately 2.1 Km to the southwest. Under extremely stable conditions with light winds impacting the plume on the mountainside, a concentration of 49 PPB would theoretically result. Such a result could be obtained from the following equation.

Equ. 3.1 of Turner

$$\chi = \frac{Q}{2\pi\sigma_y\sigma_z u} \left[\exp -\tfrac{1}{2}\left(\frac{y}{\sigma_y}\right)^2\right] \left\{\exp\left[-\tfrac{1}{2}\left(\frac{z-H}{\sigma_z}\right)^2\right] + \exp\left[-\tfrac{1}{2}\left(\frac{z+H}{\sigma_z}\right)^2\right]\right\}$$

All stack parameters would be the same as noted above with the additional parameter z (difference in elevation from plant base) = 170 meters. Again, the concentration with units of g/m^3 would be converted to PPB by multiplying by 573,000 $\frac{PPB - m^3}{g}$.

II. Sulphur Dioxide

The SO_2 emissions from the stacks were also utilized with the short-term model to estimate ground level concentrations. The version of the model used from Turner was Equation 3.1.

$$\chi = \frac{Q}{2\pi\sigma_y\sigma_z u}\left\{\exp\left[-\frac{1}{2}\left(\frac{z - H}{\sigma_y}\right)^2\right] + \exp\left[-\frac{1}{2}\left(\frac{z + H}{\sigma_z}\right)^2\right]\right\}$$

The stacks were modeled separately and then the results summed to give a total concentration. The model assumes possible impaction of plume centerline with terrain only in stable cases (Pasquill categories E and F).

Table D-4

Proposed Emission Rates (SO_2) and Stack Parameters

Hoerner Waldorf Mill

Source	Emissions (g/sec) Case 1*	Case 2+	Stack Hgt. (m)	Stack Dia. (m)	Exit Vel. (m/sec)	Temp. (^oF)
Recovery #1	0	0.88	57.0	2.7	12.6	140.0
Recovery #2	4.72	2.19	57.0	2.7	18.3	410.0
Recovery #3	6.82	2.72	55.3	2.6	19.8	390.0
Recovery #4	14.70	5.80	57.0	4.0	14.3	418.0
Power Boiler	0	14.65	45.7	2.4	8.5	433.0

---

*No natural gas curtailment.
+Natural gas supply curtailed.

Results of the model listed in Table D-5 are for maximum estimates for Case 1 (no natural gas curtailment) for two plume rise conditions. The very stable case (worst case) uses plume rise stability parameter 0.000718 and the less table cases use 0.000163. Table D-6 displays results for Case 2 (natural gas curtailed).

Table D-5

Ground Level Sulfur Dioxide Estimates

(Proposed 1974)

One-Hour Concentrations in Parts per Million
No natural gas curtailment

Worst Case (very stable plume rise)
Temperature = 10° F
Wind = 2 - 3 m/sec.

Pas. Stability	Distance (Km)	Direction	Concentration (PPM)	Average Elev. (msl)
F	2.5	SW	.14	3700
F	2.5	WSW	.13	3680
F	3.0	SW	.12	3700
F	3.5	WNW	.09	3680

Typical Stable Case (Stability parameter = 0.000163)
Temperature = 42° F
Wind = 2 - 3 m/sec.

Pas. Stability	Distance (Km)	Direction	Concentration (PPM)	Average Elev. (msl)
F	2.5	SW	.06	3700
F	2.5	WSW	.05	3680
F	3.0	WSW	.07	3940
F	3.5	SW	.06	3900
F	3.5	WSW	.06	3990

Table D-6

Ground Level Sulfur Dioxide Estimates

(Proposed 1974)

One-Hour Concentrations in Parts per Million
Natural gas curtailed

Worst Case (very stable plume rise)
Temperature = 10° F
Wind = 2 - 3 m/sec.

Pas. Stability	Distance (Km)	Direction	Concentration (PPM)	Average Elev. (msl)
F	2.5	SW, WSW	.06	3700
F	3.5	SSW	.07	3490

III. Suspended Sulfates

The short-term model was also used to estimate ground level concentrations of suspended sulfates for 24-hour periods. Turner's Equation 3.1 was also the method used. Table D-7 summarizes the emission parameters used. Results for present emissions are presented in Table D-8 and proposed emissions in Table D-9. Once again, the sources were modeled separately and summed for total ground level estimates.

Table D-7

Sulfate Emissions (g/sec)

Source	Present Mill	Proposed Mill
Recovery Unit #2	0	1.43
Recovery Unit #3	3.49	3.49
Recovery Unit #4	3.11	4.38
Lime Kiln #1	0.16	0.16
Lime Kiln #2	0.44	0.44
Lime Kiln #3	0.32	0.32
Lime Kiln #4	0	0.56

Table D-8

Ground Level Suspended Sulfate Estimates

(Present Emissions)

24-Hour Concentrations in Micrograms per Cubic Meter

Typical Stable Case
Temperature = 42^{o} F
Wind = 2 - 3 m/sec.

Pas. Stability	Distance (Km)	Direction	Concentrations (μg/m^3)	Average Elev. (msl)
F	3.75	WSW, W	14.8	4000
F	7.50	S, SSW	7.0	4000
F	7.50	NNE, WSW	6.3	4400
F	11.25	W	5.1	4200
F	11.25	ENE, E, SSE	4.5	4000
F	11.25	SW	4.0	3900

Typical Neutral (Unstable Case)
Temperature = 42^{o} F
Wind = 2 - 3 m/sec.

Flat Terrain Assumed

Pas. Stability	Distance (Km)	Direction	Concentrations (μg/m^3)
B	3.75	Valley Floor	0.11
B	7.50	Valley Floor	0.09
B	11.25	Valley Floor	0.08
B	15.00	Valley Floor	0.08

Table D-9

Ground Level Suspended Sulfate Estimates

(Proposed 1974)

24-Hour Concentrations in Micrograms per Cubic Meter

Typical Stable Case
Temperature = 42° F
Wind = 2 - 3 m/sec.

Pas. Stability	Distance (Km)	Direction	Concentration (μg/m^3)	Average Elev. (msl)
F	3.75	W, WSW	21.2	4000
F	7.50	S, SSW	10.0	4000
F	7.50	WSW, NNE	9.1	4400
F	11.25	W	7.3	4200
F	11.25	ENE, E, S	6.3	4200
F	15.00	NE	5.3	4200
F	15.00	ESE	4.4	4400
F	18.75	W, WNW	3.4	4000

Typical Neutral (Unstable Case)
Temperature = 42° F
Wind = 2 - 3 m/sec.

Flat Terrain Assumed

Pas. Stability	Distance (Km)	Direction	Concentration (μg/m^3)
B	3.75	Valley Floor	0.16
B	7.50	Valley Floor	0.14
C	11.25	Valley Floor	0.12
C	15.00	Valley Floor	0.11
C	18.75	Valley Floor	0.10

Further estimates of sulfate levels were made using a "multi-box model" suggested by Derrick (1) from the University of Montana. Estimates were made using a 700-foot inversion and three-hour average wind speed and direction as recorded at Johnson-Bell Field. The model used previous day's sulfate levels and sulfate production figures reported by Environmental Research and Technology, Inc. (2). Sulfate production was increased to include the four lime kilns.

Results of the model were below those reported by Derrick and also below the recorded values at the various monitoring sites in the valley (Table D-10). This discrepancy would seem to indicate a more thorough emission inventory is needed. The box model used assumed that HW produced 60 percent of the sulfates in the valley. Either this value is too high or some of the sulfates produced earlier and settled out are reentrained into the atmosphere each day.

This would cause HW's daily sulfate production figures to be too small for use in the modeling analyses. This would cause box model estimates to be below the values recorded.

Table D-10

Box Model Results for December 10, 1974 ($\mu g/m^3$)

Sampling Site	Observed	Derrick	SDHES
Target Range	7.9	9.24	6.72
Courthouse	12.1	10.06	7.60
Airport	14.0	14.24	10.61

REFERENCE

(1) Derrick, W. R., et. al., A Multi-Box Model for Predicting Valley Air Pollution, Bureau of Quantitative Studies, University of Montana, Missoula, Montana, 1974.

(2) McNaughton, Daniel J., et.al., An Assessment of the Air Quality In the Vicinity of the Hoerner-Waldorf Kraft Paper Mill in Missoula, Montana, ERT Document No. 0973, July, 1974.

APPENDIX E

MISSOULA CITY-COUNTY HEALTH DEPARTMENT

COUNTY COURTHOUSE ANNEX, ROOM 301

MISSOULA, MONTANA, 59801

October 16, 1974

Dr. John Anderson, Director
State Department of Health
and Environmental Sciences
Helena, Montana 59601

Dear Dr. Anderson:

This letter is in reference to my current position relative to the proposed Hoerner-Waldorf plant expansion. You may find some of these suggestions helpful to you in your impact statement.

First, I think it is helpful to review the progress of the last fourteen months. In August of 1973, Hoerner-Waldorf's original proposal included a 45% increase in estimated particulate emissions from the proposed expansion. There were numerous other environmental pollution problems and questions raised by the proposal. Subsequently, a fairly effective air monitoring system has provided some answers to these questions. Moreover, in May of 1974, a considerably improved proposal was submitted by Hoerner-Waldorf to the State Board of Health; however, this proposal still included an increase in the emission of particulate levels. The proposal submitted by Hoerner-Waldorf in October 1974, for the first time predicted a slight decrease in particulate levels. I feel this is crucial because: 1) the particulate levels are one of our most significant ambient air problems in Missoula and 2) it reinforces the public health policy of allowing no further degradation of ambient air.

The major problem which remains with the present Hoerner-Waldorf proposal is the 40% increase in sulfate emissions. The modeling done by Hoerner-Waldorf's meteorological consultants indicates this would increase the plant's contribution to sulfate levels in the valley from 0.2 to 0.3 $\mu gm/m^3$ on an annual average. Work which I have presented previously to the Air Pollution Advisory Board based on empirical observation of changes in ambient sulfate levels associated with changes in sulfate production changes by the mill from 1970-73, indicate Hoerner-Waldorf's present contribution to sulfate levels at the Courthouse are in the order of .5 to 1.5 $\mu gm/m^3$; with a 40% increase in production of sulfates by the mill this would produce an expected contribution of .9 to 2.2 $\mu gm/m^3$. In either case, it is recognized that Missoula is close to the State limit of sulfates with an annual average of about 4 $\mu gm/m^3$.

Our present knowledge of the effect of sulfates on human health is extremely weak for the purposes of making a decision relative to the most probable impact of the expansion upon human health. Significant questions have been raised within the last two years in the medical literature relative to the possible primary importance of sulfates relative to human health as opposed to other air pollutants. Some of these studies indicates sulfates may have adverse human health effects at levels as low as $1.4\ \mu gm/m^3$. However, at the present time, we cannot draw firm conclusions as to either the most probable effects of sulfates in general on human health, or the most probable effects of sodium or other sulfates in the Missoula air shed on human health.

Based on consideration of the above factors, I feel that it would be reasonable for the State Department of Health and Environmental Sciences to grant an expansion permit to Hoerner-Waldorf at this time; however, in addition, to other conditions which may be imposed by consideration of water discharge or other non-human health factors which I have not discussed above, I feel that health considerations dictate a minimum of the following:

1. There must be verification of any data in the proposed expansion plans which presently are in doubt.

2. There must be strict adherence to the intent of the expansion plans with limitation of emissions as described.

3. We must have continual ambient air monitoring of the most probable mill emissions until at least two years after the expanded mill is in full production. The monitoring should be done at three sites: 1) in the Frenchtown area, 2) in the Target Range area, and 3) in the Missoula urban area. The substances monitored should minimally include suspended sulfates, totally reduced sulfates, hydrogen sulfide, and sulfur dioxide. In addition, it would be helpful if nitrous oxides and carbon monoxide could be monitored.

4. If adverse health effects should be proven to be associated with sulfate levels in Missoula, then the State Department of Health and Environmental Sciences must enforce a curtailment in sulfate emissions by Hoerner-Waldorf to acceptable levels.

A note of commendation should be given to your staff for the excellent work they have done in attempting to obtain protection of the air quality in the Missoula Valley.

Sincerely,

Kit G. Johnson, M.D., M.P.H.
Health Officer

KGJ/jmo

BACKGROUND AND EDUCATION OF PERSONS PREPARING THE FINAL ENVIRONMENTAL IMPACT STATEMENT FOR THE PROPOSED EXPANSION OF HOERNER-WALDORF'S MILL

Donald Holtz, Chief, Air Quality Bureau, B.S., Mechanical Engineering, Montana State University, 1960: registered professional engineer, Montana; nine years experience in air pollution control.

Carl Ripaldi, B.S., Botany, University of Massachusetts, 1968; M.S., Plant Pathology, Rutgets University, 1973; research on the effects of air pollutants on vegetation; seven months' experience as an Air Pollution Control Specialist in Vegetation for the Air Quality Bureau.

David Maughan, B.S., Chemistry, Brigham Young University, 1968; M.A., Physical Chemistry, University of Utah, 1971; two years' metabolic disease research, University of Utah School of Medicine; three years' experience in air quality monitoring and related data processing meteorology and laboratory analysis with the Air Quality Bureau.

Daniel Vichorek, B.A., Journalism, University of Montana, 1969; experience as a general assignment and police reporter for the Billings (Montana) Gazette and the City News Bureau of Chicago; 16 month's experience as a Technical Writer for the Environmental Sciences Division.

Don Willems, Chief, Water Quality Bureau, B.S., Sanitary Engineering, University of Illinois, 1951; M.S., Civil Engineering, University of Florida, 1959; registered professional engineer, Montana; Technical Service Engineer on water and wastewater equipment, Infilco, Inc., Tucson, Arizona, 1951-56; experience in water pollution control with the State Department of Health and Environmental Sciences, 1956-58, 1959 to present.

James Brown, B.S., Civil Engineering, South Dakota School of Mines and Technology, 1970; M.S., Environmental Health Engineering, University of Texas at Austin, 1973; Public Health Engineer, South Dakota Department of Health, 1970-72; Public Health Engineer, State Department of Health and Environmental Sciences, September, 1973 to present.

Abe Horpestad, B.S., Botany, Montana State University, 1966; M.S., Botany, Montana State University, 1969; three years' experience as a water quality research assistant, Montana State University; two years' experience as Consulting Ecologist, Union Carbide Corporation, Instructor, University of California, Riverside; aquatic ecology; limnological consultant for the Water Quality Bureau, September, 1973 to present.

Maxwell K. Botz, B.S., Geological Engineering, University of Nevada, 1957; M.S., Geological Engineering, University of California, Berkely, 1962; registered professional engineer, Colorado and Montana; three years' experience as a geological engineer; Chief Hydrologist and Associate Professor of Geology, Montana Bureau of Mines and Geology and Montana College of Mineral Science and Technology, 1965-1970; hydrogeologist and consulting engineer, 1970-72; Water Quality Engineer for the Water Quality Bureau, 1972 to present.

Jon Bolstad, B.S., Chemical Engineering, 1971, Montana State University; Approximately three years' experience in air pollution control with the Air Quality Bureau.

James W. Gelhaus, B.S., Mathematics, South Dakota School of Mines and Technology, 1970; M.S., Meteorology, South Dakota School of Mines and Technology, 1972; Air Pollution Control Specialist, Air Quality Bureau; three years experience in meteorology.